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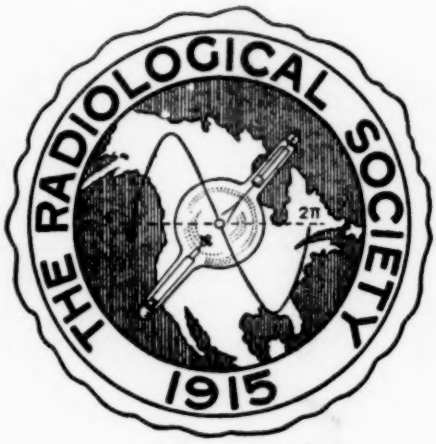

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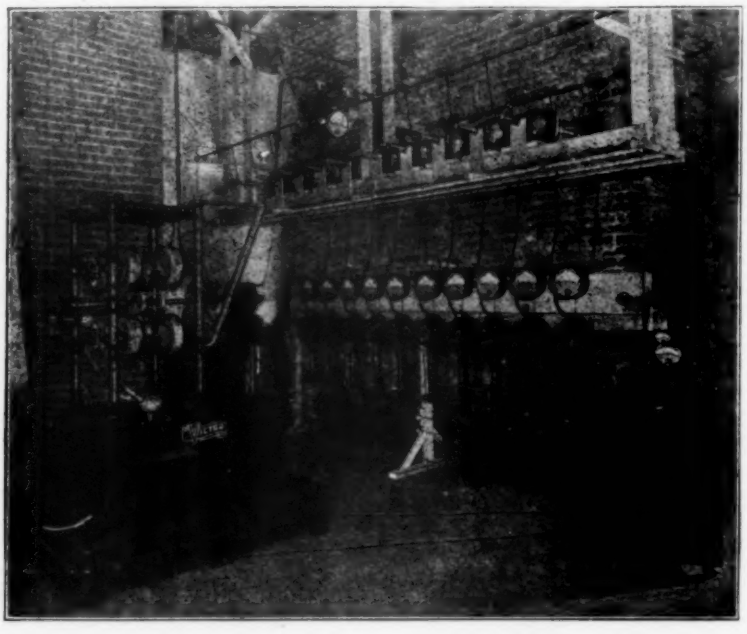

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Carcinoma of Lingual Thyroid With Metastases in the Lungs*

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Definition

BY THE TERM "lingual thyroid" is meant an aberrent thyroid located in the root of the tongue. The most frequent location is in the posterior aspect above the hyoid bone. This is the location of the tumor in the case under discussion.

Historical

The first to call attention to thyroid tumor in the tongue was Verneuil, who made the following report in 1853. He says, "while dissecting the insertions of the muscles of the tongue on the hyoid bone, a small glandular mass was exposed which was quite strongly adherent to the middle part of the glossus muscles. This mass was red, soft and sessile, the size of a large pea, with a smooth, shining surface and composed of a homogeneous tissue which upon microscopic examination proved to be that of the thyroid gland."[1] This report was made by an anatomist. Since then, much has been written on this subject by such investigators as Zuckerkandl, Kaydi, Gruber and Madelung.

The first case reported in American medical literature is that of Bernays[2] in 1888. In 1904, Storrs[3] found 29 cases previously reported and added three more. In 1920, Lenormant[4] reported 43 cases, thus adding 11 to those already in the literature. In 1922 J. N. J. Hartley[5] reported one additional case, bringing the total number of cases reported in medical literature up to 44. Of these cases, all were proved by microscopical examination to be normal thyroid tissue. The case which I am adding is the first lingual thyroid, so far as I have been able to determine, which has shown malignant change. Of the 44 cases previously reported, three were males and 41 were females. My patient was a male. Through the courtesy of Dr. Louis McArthur, who operated upon this patient, I am privileged to show a microscopical section of the primary tumor in the root of the tongue (Fig. 1).

*—Read at the Annual Meeting of the Radiological Society of North America, Detroit, Dec. 7, 1922.

Embryology

It will be recalled that during the third week of embryonic life the tongue begins to form. It is formed in two parts, the buccal portion makes up that part of the tongue seen on casual observation through the open mouth in the adult. Embryologically, it is situated in front of the foramen cecum and the V shaped groove. It is covered by papillae, is concerned in mastication and is apt to develop cancer. The phalangeal portion bounds the buccal wall of the pharynx, is covered by glandular and lymphoid tissue and is concerned in swallowing[6]. The buccal part arises as an elevation (known as the tuberculum impar) from the middle portion of the first arch and first interbranchial space. The pharyngeal portion is formed by the second and third arches.

At the same time that the formation of the two parts of the tongue is taking place, a mass of hypoblastic tissue appears in the middle of the furrow between them. This mass forms a solid outgrowth which descends ventrally and caudad to the level of the normal thyroid in the neck. During the second month this mass bifurcates, forms acini and is recognized as the isthmus and major portion of the lateral lobes of the thyroid gland. The path made by the migration of the thyroid is known as the thyroglossal duct, the buccal opening being known as the foramen cecum. Normally, the thyroglossal duct is obliterated at the time the two portions of the tongue are fused. Occasionally, however, some remnants of thyroid tissue are left along the path of descent. When this happens we have a lingual thyroid.

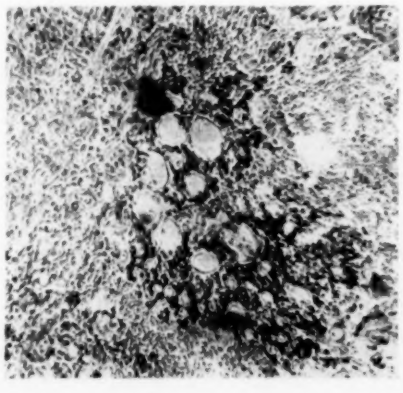

Fig. 1 — Microphotograph of section made from tissue removed from the root of the tongue. Notice the presence of colloid material.

Lingual thyroids are divided into two types, depending on the location of the tumor with respect to the hyoid bone. The more frequent variety is that above the hyoid bone. It is this type with which we have to deal in this discussion.

Etiology

Primarily, lingual thyroid is a defect in embryological development. It is interesting to note, however, that it occurs much more frequently in women than in men. Of the 45 cases reported to date, 41 are females and 4 males. The reason for this is not understood any more than we understand why goiters of all kinds are much more frequent in women.

Since lingual thyroid is due to a defect in embryological development, it is found at all ages, from birth to advanced years. In the case reported by Hickman[7] we find a tumor of sufficient size to produce suffocation in a newborn child, while in the autopsy reported by Staelin[8] the subject was a woman of 77 years. My patient was a man of 54 years.

Although present from the first month of intraterine life, lingual thyroids seldom produce symptoms until the time the sex life becomes active. This means that they are usually recognized in women between the ages of 15 and 40. This fact leads one to think that the thyroid tissue found in the tongue undergoes hypertrophy as the ovarian function becomes active. This has been proved in cases where myxedema followed the surgical removal of lingual thyroid, no normal thyroid being present, as in the cases of Seldowitsch,

Kraska and Hartley. On the other hand, Benjamins reports a case of myxedema in a man following surgical removal of a lingual thyroid.

Pathology

The lingual thyroid is usually located above the hyoid bone in the posterior portion of the tongue at the site of the V shaped groove where fusion of the buccal and pharyngeal portions has occurred. It may be centrally located surrounding the foramen cecum as in Bernay's case, but more frequently it is slightly to one side. The tumor is usually ovoid in shape and varies in size from one-half centimeter to five centimeters in diameter. The mass usually produces a prominence on the dorsum of the tongue and when large, projects downward showing under the mandible and above the hyoid bone. When of this size, the root of the tongue will feel thick and boggy to palpation. In lingual thyroids of normal histology, the mucosa of the tongue remains unbroken, but has a bluish color, due to the engorged veins noted at laryngoscopic examination. Occasionally, profuse hemorrhage occurs, due to rupture of one of the vessels involved in the lingual thyroid. Rarely, malignant degeneration may occur.

Symptoms

The leading symptom is that of a feeling of pressure in the throat, causing the patient difficulty in swallowing or in breathing. There is usually a desire to "clear the throat" frequently. This symptom is usually present several years before the cause is recognized.

In some cases the patient may have a severe hemorrhage from the throat due to rupture of one or more of the enlarged vessels in the growth.

Palpation of the tongue with the gloved finger, well back in the pharynx, will reveal the induration and elevation characteristic of lingual thyroid. In addition to this, the laryngoscopic examination will show the engorged vessels and the bluish discoloration characteristic of the thyroid gland.

The presence of all these local symptoms with the complete absence of constitutional symptoms should make one suspicious of the presence of a lingual thyroid.

There are other tumors which may occur in the root of the tongue. Sarcoma, lipoma, angioma, fibroma, syphilitic gumma, lingual tonsil and cyst, make up the list.

Treatment

Medical treatment, such as the administration of sodium iodide and other internal medication, seems to have little or no beneficial effect. X-ray or radium therapy has not been tried on the normal lingual thyroid. In my case, where complete surgical removal was impossible and malignant change had taken place, x-ray and radium were used with great benefit. Metastases had already occurred so that complete cure was made impossible even by radiation. Some have used the galvano-cautery, but with failure because of inability to remove all the thyroid tissue. Clean surgical excision, then, is the best method. Two routes are possible in

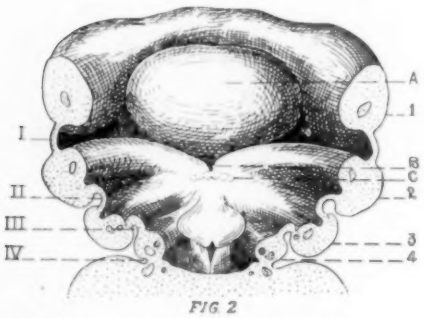

FIG 2

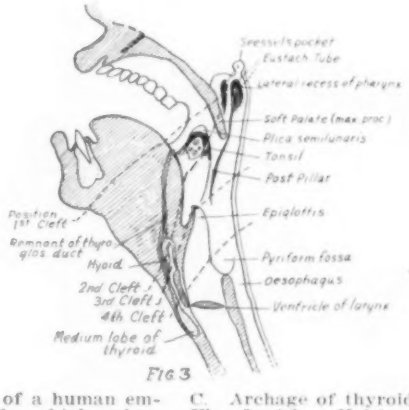

FIG 3

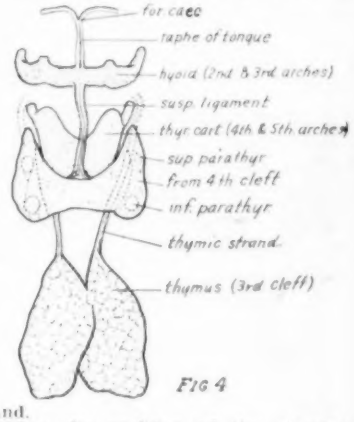

FIG 4

Fig. 2—Vertical section through the pharynx of a human embryo of ten millimeters. After His. 1, 2, 3, 4 Branchial arches. I, II, III, IV, Branchial clefts.
A. Tuberculum impar forming front portion of tongue.
B. Foramen cecum.
C. Archage of thyroid gland.

Fig. 3—After Keith. Showing the position of the visceral clefts in the adult.

Fig. 4—After Keith. Diagram of the thyroid and thymus. The three parts of the thyroid body are indicated by stippled lines.

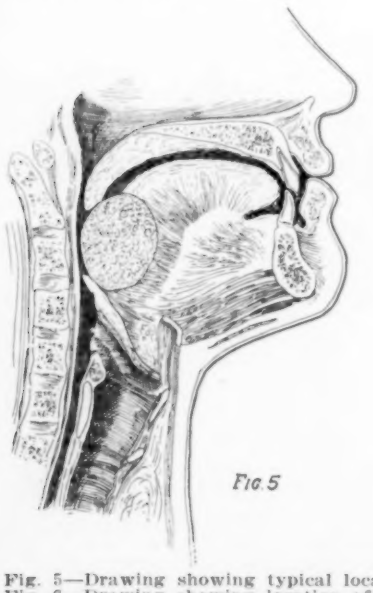

FIG 5

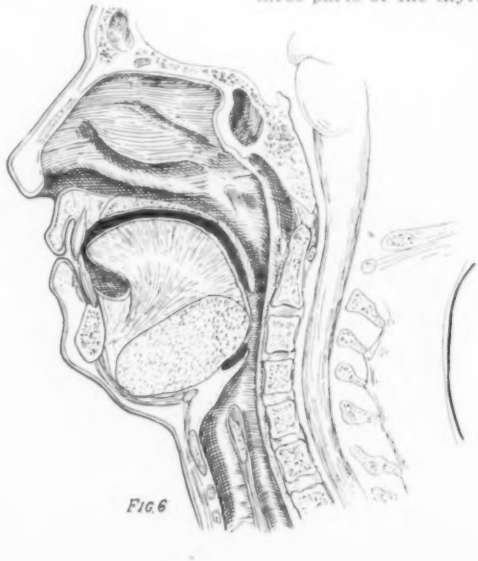

FIG 6

FIG 7

Fig. 5—Drawing showing typical location of lingual thyroid.
Fig. 6—Drawing showing location of tumor in the case now reported.

Fig. 7—Drawing showing appearance of tumor on dorsum of tongue in case now reported.

surgical removal, the intraoral and the extraoral. The intraoral is feasible where the mouth is large, the tongue long and slender and the tumor small and situated close to the dorsum of the tongue. In the cases where a large tumor is present, the extraoral attack is to be recommended. In this operation the incision is made in the midline below the mandible and ends of the hyoid bone. Through this incision enucleation is done. In very large tumors the incision is carried downward through the hyoid bone to the upper border of the larynx. When this technique is necessary a tracheotomy must first be done.

There have been no surgical deaths in the cases reported. Healing has been rapid and complete and the patients have quickly returned to the customary employment. It is important to determine the presence of a thyroid at the normal location before operation, in order that myxedema may not be produced by removal of the lingual thyroid.

Fig. 10—Photograph of gross specimen of tongue, showing necrotic area occupying left posterior quadrant of tongue and extending down to epiglottis.

Case Report

The following is a report of the case under discussion:

Diagnosis: Aberrant thyroid gland in the root of the tongue which has undergone malignant degeneration. March 23, 1921—Metastases in the lung.

Chief Complaint: Difficulty in swallowing.

Past History: Patient had never been incapacitated.

Present Illness: Eight years ago the patient first noticed a small lump at the base of the tongue. He went to a doctor and received local treatment for a while. The lump did not cause any discomfort, because no larger and so he neglected it until five years ago, when he was operated upon. An incision was made on the left side of the neck below the mandible and something removed which was believed to be an enlarged gland. February 12, 1920, he was again operated upon. This time the incision was made in the middle line under the chin, above the hyoid bone. The patient was told he had a goiter in the root of the tongue.

Physical Examination: A tumor mass hard and fixed at the base of the tongue on the left side.

X-Ray Examination: March 23, 1921. Many small areas of increased density definitely circumscribed, ranging in size from a pea to a small orange, numbering more than thirty, scattered throughout both lungs. August 15, 1922. There are several hundred small areas of consolidation throughout both lungs, probably metastatic from the tongue.

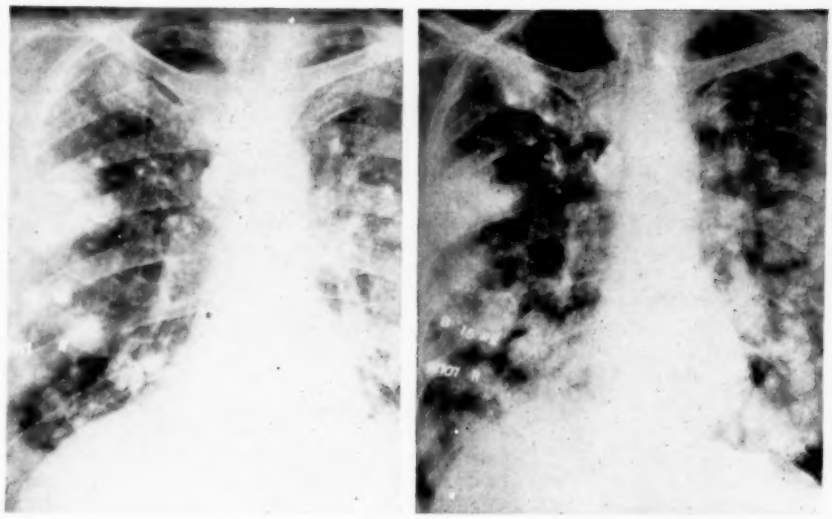

Fig. 8—Roentgenogram of chest of patient August, 1921, showing metastatic tumors in both lungs.
Fig. 9—Roentgenogram of chest of same patient August, 1922, showing great increase in number and size of metastatic tumors in lungs.

Treatment: *Surgical*—On February 12, 1920, an incision was made in the middle line of the neck beneath the chin, in order to gain access to the midportion of the tongue for the purpose of scooping out with a curette, a fragment for microscopic examination. Microscopical examination proved the tissue to be thyroid with hyperplasia. *X-Ray*—At intervals from March 16, 1920, to October 23, 1922, the patient was given x-ray therapy over the mediastinum, neck and abdomen through various ports of entry. *Radium*—June 20, 1920—400 milligram hours of radium was given to the tongue, using 1.5 millimeters brass filter.

Result: Metastases in the lungs, and retroperioneal glands. Patient died.

Fig. 11—Photograph of lungs showing multiple nodules studding surface.
Fig. 12—Photograph of cut surface of lung showing multiple tumors in section.

Postmortem Findings: Dr. B. C. Russum. There was a necrotic area three centimeters in diameter involving the posterior portion of the tongue from the middle back to the epiglottis, and from the left margin well toward the right margin (Fig. 10). The lungs were studded with multiple areas of new growth varying in size from one millimeter to ten centimeters in diameter (Fig. 11). Cut section of the lung showed these areas well distributed throughout the lung (Fig. 12). There were many enlarged glands along the spine in the mediastinum. The abdominal viscera were negative except for many scars on the parietal peritoneum and mesentery. There were no enlarged glands.

Conclusions

1. Lingual thyroid is a tumor in the root of the tongue due to a failure of the thyroid to entirely migrate to its normal position during embryonic development.
2. Histologically and clinically, it has the characteristics of the thyroid.
3. It is most frequently found in women, 40 to 5 being the proportion in reported cases.
4. It may undergo malignant degeneration and metastasize through the blood stream.
5. Surgical enucleation is the best treatment.
6. X-ray and radium treatment is beneficial in cases where surgical removal is impossible or where malignant degeneration has occurred.

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Cancer From The Surgical Standpoint*

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AS FAR BACK as the history of surgery reaches, surgeons have considered cancer curable in the early stages of the disease, and entirely hopeless after metastases have formed.

The statement concerning cancer which is attributed to Celsus, who lived before and during the beginning of the Christian era, has remained a surgical truth during all of the past centuries. He is quoted as saying "Only the beginning of a cancer admits of a cure; but when it is once settled or confirmed, it is incurable and the patient must die under a cold sweat."

It is a fact that when we recall the cases in our personal experience we must agree with Celsus, because it is only in those cases in which we can remove the entire growth that we can hope for a permanent cure.

There are certain regions of the body in which this is less difficult than in others, and it is in these regions that the surgeon has recorded most of his successful cases.

Again, there have been certain forms of surgical treatment which have been more certain to remove all of the cancerous tissues in these early cases.

The proportion of permanent cures in cases in which I have removed the tumor by means of the actual cautery has been much greater than those in which I have used the knife, and the only apparently hopeless cases in which I have observed a permanent cure are those in which I destroyed the tumor and the surrounding tissues with the cautery, with the exception that since we have employed x-ray and radium we have had quite a series of apparently hopeless cases in which, up to the present time, there has been no recurrence, and a number of these cases seem to have resulted in a permanent cure.

There are four very distinct reasons why the removal of an early cancer by means of the actual cautery, preferably a red-hot soldering iron, should result in a higher percentage of permanent cures than the removal with the knife.

1. The heat is carried far beyond the point at which the tissues are severed and consequently the cancer infection which may exist beyond the line of incision is likely to be destroyed by this heat.

2. We know that if one takes a piece of cancer tissue from the breast of a mouse, cuts it in halves, transplants one piece fresh and heats the other to 160 degrees Fahrenheit before transplanting it, that the former will grow while the latter will not. It is plain, consequently, that the tissue outside of the cut surface, which has been exposed to the red-hot soldering iron, is not in a condition to act as a cancer graft, while if the tumor is excised with the knife, any portion of the infected tissue beyond will be sure to grow.

3. A knife passing through tissue infected with cancer may act as a means of carrying cancer infection into portions of the non-infected wound. Undoubtedly, the recurrence of cancer in the form of nodules in the scar, following excision of the breast for cancer, is due to implantation of cancer particles with the knife during the operation.

4. In operating with the knife, one is constantly tempted to take away as little tissue as possible, in order to secure a cosmetically perfect result.

One can readily see to what extent these conditions will reduce the chances of thoroughly eradicating a circumscribed cancer infection in case the knife is used in place of the cautery.

Personally, I have been convinced for many years as a result of my clinical observations that cancer is due to a specific infection.

The experiments of John Nuzum which resulted in the isolation from human cancer of a micrococcus which could be cultured and injected in the form of pure culture into the breasts of mice and dogs, who later died from metastatic cancer from which the same microorganisms could be isolated, have still further confirmed me in this belief and have convinced me that the cautery is far superior to the knife for the removal of malignant growths.

It is possible that still better results may be obtained by the use of diathermy, but my experience with this form of treatment is not sufficient to entitle me to an opinion.

We have repeatedly removed carcinomatous breasts or tumors of the neck with the red-hot soldering iron, and

*—Read at the Annual Meeting of the Radiological Society of North America, Detroit, Dec. 5, 1922.

have dissected the axillary or cervical lymph glands with the electric cautery in cases which seemed hopeless and there has been no recurrence for many years. In all these cases, however, the patients have had after treatment with x-ray so that we cannot be certain about the part each of the two methods had in preventing recurrence.

During the past few years so much progress has been made in determining the proper dosage of x-ray and radium by those who have studied the subject, both from a scientific and an experimental side and from extensive clinical observation that I have considered it best to place the radiologic treatment of my cancer cases entirely in the hands of Dr. Henry Schmitz, an expert radiologist. At the same time, I have never ceased giving these cases my continued interest, because it seemed important to give them the benefit of experience obtained throughout years of observation covering hundreds of cases. I have found that our combined judgment has been valuable to both of us, and it seems that in time such teamwork must bring results.

So far, then, we feel certain that quite a number of lives have been actually saved by wide excision preferably by means of the actual cautery and that many of our patients are alive today who would have died years ago had they not been treated with radium and x-ray, either combined or singly.

At the present time we feel that we should treat all cases of malignant growths with x-ray before operating.

We are not certain whether it is best to operate immediately after the patient has recovered from the depressing effect of deep x-ray therapy, or to wait several days or weeks following this time. At present, in all cases in which it seems as though the patient has a chance for a permanent recovery after the removal of the cancer, we operate within a week after the patient has recovered from the depressing effect of the x-ray or radium treatment.

In many cases we have given several courses of x-ray treatment at intervals of from six to sixteen weeks following the operation. A number of these cases are alive after from five to sixteen years.

Since using a more powerful machine we have usually given only one prolonged treatment following the operation. We are not certain as yet whether this plan excells the other.

In some cases it has seemed as though patients who received one prolonged intensive treatment before the operation and none after were more likely to remain free from recurrence than those who were treated before and after.

It seems wise not to be too positive as yet regarding the adoption of any definite method until all methods have been thoroughly tried in a very large series of cases.

Following the very extensive excision that we make we observe the case for years in order to discover local recurrence very early, because we have learned that by destroying these immediately with the actual cautery it is sometimes possible to eradicate the cancer infection, while if the recurrent nodule attains any considerable size before it is destroyed with the cautery, the patient is almost certain to die of metastases.

Early Operation

Many years ago I had a number of experiences which impressed themselves forcibly upon my memory.

I recall a number of cases which came to me so early that with my present experience I am morally certain that they could have been permanently cured if the growth had been promptly removed with the cautery, or in early cancer of the uterus, if the organ had at once been freely removed preferably by severing the vaginal attachment with the cautery.

In these cases three blunders resulted in the death of the patient:

1. Waiting to make certain that the diagnosis of cancer was correct. By the time this was accomplished, metastatic infection had occurred and the case was hopeless.

2. Scrapings or sections of the suspicious tissue were examined microscopically. At that time these specimens were removed with the knife or the curette. These patients died regularly from metastases. Not a single case in which the scrapings or the piece excised with the knife showed the presence of cancer has escaped death as a result of metastatic infection.

3. The tumor was removed with the knife, care being taken to obtain a good cosmetic result. These patients had local recurrence and later metastases, and they all died.

The unfortunate circumstance lies in the fact that these blunders were made in just those cases that had almost a perfect chance for permanent recovery had they been treated decently.

Excision of portions of suspicious growth to confirm a diagnosis of malignancy has been insisted upon by some and condemned by others and the arguments on both sides are so well known that they need not be repeated here. The only case in which I am willing to expose the patient to the danger of dying, as a result of metastases caused by diagnostic excision of a portion of a growth suspected of malignancy, is when the removal of the growth would result in the unnecessary sacrifice of a limb or an important organ or would produce an extensive deformity. In such cases the piece removed should be sufficiently large for a positive diagnosis, and the removal should be accomplished by the use of the electric or the Paquelin cautery so that the lymph channels and blood vessels will be sealed, and will not carry cancer fragments to distant parts. Moreover, in these cases, in my opinion, it is better to remove the entire tumor so that portions from different parts can be taken for examination, because frequently microscopic sections from one part may fail to show malignancy in growths in which other portions are plainly malignant.

Moreover, the examination should be made at once, and if the result does not absolutely establish the fact that the growth is benign, the operation should be completed at once. In my experience, many cases in which the benignity of a growth could not be established positively by the preliminary microscopic examination, have proved to be malignant on thorough examination. In many excisions of early cases of cancer I have for many years followed the rule to remove at the first operation as much tissue as one usually expects to remove after the first recurrence following the primary operation without regard to the cosmetic result. As a matter of fact, it does not matter much how badly the wound looks after a really extensive removal. One can always get a better cosmetic result later on than one can following an operation for recurrence.

If one recalls the saying of the ancients regarding epithelioma "Be unwilling to touch me" (nolle me tangere) it is easy to understand why one should make an extremely wide excision, and also why this excision should be made with the cautery.

The ancients had observed that these skin cancers were fairly certain to remain stationary for a long time if not touched, and that when once started in their growth the case became hopeless.

How often have we not seen a pigmented nevus remain apparently perfectly harmless until it was accidentally crushed or incompletely removed when it would spread violently, producing great numbers of metastatic tumors which would in a relatively short time destroy the life of the patient?

All tumors in their incipiency seem to have a surrounding area which prevents their invasion of adjacent tissues except by very slow infringement. Let this immunizing area be disturbed by a trauma or by the surgeon's knife, and there is at once rapid progress with the formation of metastases.

We saw this early in my experience. Some thirty years ago when osteopathy first appeared many cases of cancer of the breast that came to the hospital had had their tumors manipulated vigorously by the osteopathic practitioners, and most of them had metastatic tumors when they came to our clinic. Later these practitioners learned not to manipulate apparently malignant growths, and as a result this complication became less common.

In our enthusiasm over results of treatment of early cases of cancer, we must not forget the far greater importance of seeking for means of prevention.

In order to appreciate the importance of this, we must try to visualize the ravages of cancer in this country.

We are paying billions of dollars for our portion of the expenses of the late war and other billions to prevent future wars. The number of deaths from wounds inflicted upon American citizens in the late war was somewhat less than 50,000. The number of deaths from cancer since the close of the war has been more than 300,000 in the United States, according to reliable statistics.

Unless we find some means of preventing cancer we must expect to lose a number of citizens of the United States every single year, greater than the total number of lives lost in our army during the late war.

A portion of this loss can be eliminated if we continue our propaganda, so that a constantly increasing proportion of cases come under our care before metastases have formed, and the family physician and surgeon appreciate more and more the harmful effect of temporizing, and the great importance of making an absolutely radical removal the moment the patient comes for examination. The appreciation of the whole profession of the value of x-ray and radium applied according to the directians of a competent, thoroughly scientific, experienced radiologist will help greatly in saving many cases that are now hopelessly lost.

Speaking of cancer from the surgeon's standpoint, I would suggest the following conclusions:

1. The most important work the surgeons and the whole medical profession can do is to develop methods for the prevention of cancer.
2. Eliminate all sources of irritation.
3. Eliminate all sources of filth.
4. Eat only clean food or cooked food.
5. Encourage patients to come early for examination.
6. Make a careful, thorough examination in every case.
7. When in doubt, remove the growth as thoroughly as though you were not in doubt.
8. Remove a malignant growth at the primary operation as widely as you would expect to remove it after the first recurrence.
9. Use the actual cautery whenever it can be used.
10. Always work in conjunction with a competent radiologist.
11. Observe every patient at stated intervals after the operation, and destroy any recurrent nodule at once with the cautery or with radium.

Newer Investigations of Gamma-Ray Dosage of Radium*

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FOUR years ago I published my first paper[1] on methods and results of γ-ray dosage measurements. I attempted in that paper to replace by a simple and direct method the purely empirical and consequently inaccurate dosage of radium then in vogue. The method of measuring was published in full at that time in *Strahlentherapie*,[2] and a year ago appeared in English in the appendix of *Principles of Physics and Biology of Radiation Therapy*, translated by Schmitz[3]. The doses computed by this method have given uniformly consistent results since its publication, for instance, Professor Schmitz and Dr. Bachem showed good results obtained from dosage calculated according to this method.[4]

Since the first publication I have made a series of measurements with different combinations of capsules, partly in cooperation with Professor Friedrich and Mr. Huth at the Freiburg University. I am indebted to Mr. Huth for the drawings shown in the following pictures. The object of this paper is to give you a short report of these later results.

Before coming to this report I should like to emphasize the fact that the solution of the purely physical questions is not the complete solution of the whole dosage problem. The biological factors are of prime importance, but hitherto results based purely on biological research have not given a correct idea of these factors. But this objection does not affect the physical factors which are capable of fairly accurate determination. I think we must apply all the known physical data as exactly as possible if we wish to solve the biological questions. When these questions have been solved then we will be able to measure exactly how they modify the physical dosage.

I.—Measuring Apparatus

For the sake of completeness permit me to briefly review the type of measuring apparatus. This apparatus appears in the upper right hand corner of the first figure.

Of especial importance is the small ionization chamber "K" which measures in connection with the Wilson electrometer "E" the distribution of the dose around the radium capsule "Ra" at every point of the radiated medium. In order to be able to apply the measured doses directly to the tissues a water phantom was used, water and the average human tissues having, as you know ,about the same absorption and scattering properties. All possible errors in the measurements were taken into account and the readings corrected as accurately as possible.

II.—Measuring Results

Let us pass at once to the results:

(a) Scattered rays. First, it was observed, as in the case of roentgen rays, that in the case of the application of radium, the scattered rays arising in the medium cause an increase of the direct dosage. Consequently, the calculation of the distribution of the dosage here, as with the application of x-rays, from the laws of distance and absorption alone, is incorrect.

(b) Isodoses. It was therefore necessary to measure the total dosage distribution entirely around a given radium capsule or around combinations of several capsules. All the succeeding diagrams (Fig. 1 and Fig. 2) show the distribution of the dosage in one plane, from capsules built according to our own specifications, viz., length 25 mm., diameter 3.5 mm., in a silver container evenly filled and with a filter of 1.5 mm. of brass in order to have practically only γ-rays.

Those points at which in a given time equal doses are delivered are con-

*—Read at the Annual Meeting of the Radiological Society of North America, Detroit, Dec. 6, 1922.

nected. The resulting curves of equal intensity in a given time I designated four years ago as *isodoses*. In order to have a distinct picture and one which can be used under all circumstances, all the doses have been calculated in percentages of the isodose 100 at the distance of 1 cm. from the center.

In the diagrams you see the isodoses of one capsule; of two, one behind the other; of three, one behind the other; and of two and three, side by side; cross sections of all combinations and the longitudinal section of the last mentioned combination.

III—Practical Conclusions

What may one immediately learn from these curves?

(a) The points of equal doses do not run parallel with the surface of the capsule, but show characteristic deviations. These are caused by the absorption relations in the radioactive material and in the filter. A special deviation to be noted here is that at the end of the capsule the dose delivered to the adjoining tissues is only about half of the dose which is delivered in a given time at the midpoint of the capsule; the ends are not, as is often supposed, the site of the higher doses.

These findings as measured with the ionisation chamber have been questioned. For instance, I recall here my discussion with Rolf Sievert in the *Acta Radiologica*. Therefore, I tried to prove the correctness of the measured form of isodoses by means of a combined photographic method (x-ray and radium) in which points of equal blackening were connected. In the upper left hand corner of the first figure you see one of the resulting diagrams. We see the same characteristic form of isodoses.

The further away, the more equal the relations become, as is already known theoretically. With the combination of the capsules there is a much more even distribution. For practical use, combinations are therefore to be preferred under conditions to be hereafter explained.

(b) The isodoses enable one to determine immediately the exact dosage delivered at every point of the rayed medium. It is not necessary to emphasize the great importance of being able to do this, but I would like to point out how indispensable this information is, for instance, in cases of combinations with intensity curves of roentgen rays, in adding up the total radiation intensity delivered.

Let us take up the practical determination of the dosage from the isodoses. For example, let us take an erythema dose of the first degree, as it is generally understood. At this point I would like to call attention to the fact that there is no definite sharply demarcated erythema dose, cancer dose, etc., on account of the different biological factors involved. We employ these doses only as relative land marks and must leave it to the practitioner to modify them in each specific case. Out of a large number of biological determinations of this erythema dose, and out of our own experiments, we take the average and call that dose the erythema dose, which in the human tissue at a distance of 3 cm. in 3500 mg. element hours produces an erythema dose. In the first chart (Fig. 1) these relations are visualized. At a distance of 3 cm. from the center the isodose is about 13. For all points on this curve the intensity is the same and the erythema dose is produced therefore in 3500 mg. element hours. If one, for example, has one hundred milligrams the erythema dosage here will be reached in 35 hours at all points at this isodose line. If we go over to points which are nearer to the middle, for example, at a distance of 1 cm. from the center, there we have the isodose 100. For all points on this line we will have an erythema dosage in the thirteenth one-hundredth part of 3500, that is, in about 450 mg. element hours, or, in the case of one hundred milligrams we used, for example, in 4.5 hours. Likewise, at a distance of 2 cm., where the isodose is 30 we have the proportion thirteen-thirtieths of 3500, which is about 1500, or in our example, 15 hours.

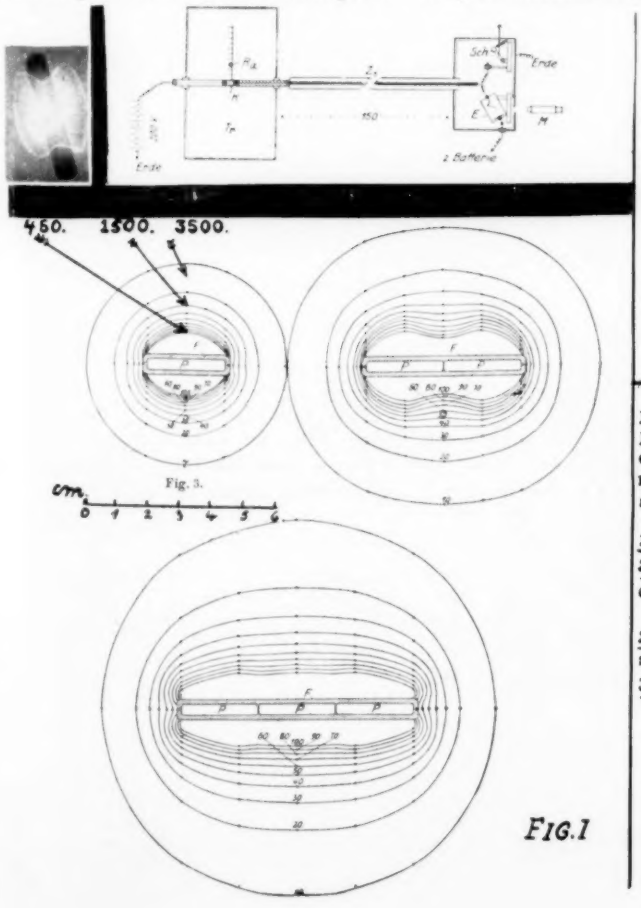

Fig. 3.

FIG. 1

Distribution of the Doses at a distance of 2.5cm from the middle of the var. arrangements:	
1 capsule	100
2 equal cap. one behind the other I.	165
2 equal cap. side by side II.	262
3 equal cap. I.	229
II.	417

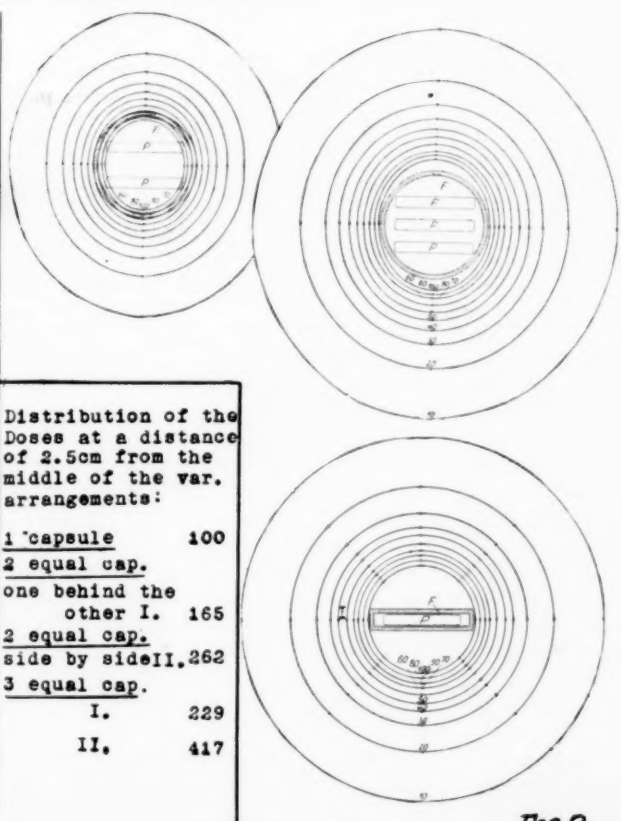

FIG. 2

Out of these few examples, which, of course, could be considerably extended, it can readily be seen that it is possible to compute in advance a pretty exact physical dose for every point in the tissue.

(c) Let us continue with the dosage distribution in the various combinations. We see from the other charts the paths of the isodoses and recognize that the determination of the dosage is exactly as above described in the case of one single capsule. However, as already mentioned, a special point must be noted with these combinations. Therefore, measurements were made by Mr. Huth at a distance of 2.5 cm. from the middle of the capsule with one capsule and with combinations of two and of three capsules. The dosage measured at this distance from the center of one capsule we arbitrarily called 100. Then measurements were made with the two and the three capsules at the same distance and the doses were compared with the findings of the single capsule. In the table of Figure 2 the very interesting findings are recorded. If two capsules are used in the same given time we do not have double the dosage, viz., 200, but in the case of the superimposed capsules only 165 (on account of the absorption conditions) but when the capsules are side by side we have instead of 200 the dose 262, due to the overcrossing of the rays. When three capsules are used the results are still more striking. Let us illustrate the importance of this fact with an example. If a 100 mg. capsule gives an erythema dose in thirty hours at a distance of 2.5 cm., then the same result will not be obtained in half the time, fifteen hours, with two capsules, but in about eighteen hours, if the capsules are superimposed, and in about eleven and one-half hours if they are placed side by side. Thereby the characteristic isodose form is not changed, but only the time of application.

How can the radiologist apply these results to his specially prepared specimens of radium. The shape of the capsule and the filter used are important factors in determining the form of the isodose, the strength of the preparation plays no part in the form of the isodoses. Since all values are relative they can therefore be computed for any number of milligram elements. If the size and shape of the container are the same as those used in my work the values may be used without modification.

If the shape and form of the containers are considerably different, then the larger scientific institutions must compute the isodoses for the respective containers, or perhaps the larger radium companies will make these important measurements.

In conclusion, I would like to mention that the isodoses of radium emanation bulbs are entirely different, on account of the small absorption in the gas. The form of the isodoses must here be more even and almost parallel to the surface of the container. These latter measurements are now being worked out, and the detailed report will follow. Likewise, we will endeavor to show to what extent the physical dosage must be modified by biological factors. But even if these latter questions are of prime importance we must first follow the path of exact practical physical dosage. With these results and with numerous biological facts to be gathered we hope to approach the true nature of the essential biological effect and eventually we will be able to determine the absolute dosage. In this connection I wish to refer to the division of the whole dosage problem into the branches of practical (relative) dosage and of scientific (absolute) dosage, as proposed by Professor Friedrich and myself for x-rays. This subject has already been referred to in our papers on the x-ray dosage problems which were read at the September, 1922, meeting of the American Roentgen Ray Society in Los Angeles. We there showed the experiments and propositions of this problem and explained that it is the purpose of practical dosage to give the radiologist means and methods of calculating and measuring the quality and quantity of rays at every point in the radiated medium. He then can reproduce and repeat every desired effect physically. Absolute dosage seeks to explain the essential biological effect of rays and based upon this to construct the ideal absolute dosage measuring apparatus from these effects.

The solution of this very important problem of ray dosage is now our chief aim.

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Duodenal Regurgitation*

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DUODENAL regurgitation, the subject of my paper, first came to my notice while I was examining the duodenal cap in a case of duodenal ulcer. Later the though occurred to me that this phenomenon might be a contributing factor in the gastric retention seen in the chronic obstructive type of duodenal ulcer. On general principles I have watched for its occurrence in all kinds of cases and am presenting my observations for your consideration.

Duodenal regurgitation as it occurs within the duodenum itself is not the type of regurgitation I mean. The following study is restricted to duodenal regurgitation into the stomach.

A brief review of American and foreign literature has revealed no previous roentgenological publication on this subject. Some references in experimental physiology were found in Alverez' *Mechanics of the Digestive Tract*, and since, Pawlow's researches extensive references are to be found in clinical literature. In fact, these clinical references are so numerous, especially within the last ten years, that roentgenologists are made conspicuous by their silence. Of special interest is Alvarez' statement that, "particularly toward the close of gastric digestion there is normally some regurgitation of the duodenal contents into the stomach," so that this point was given especial attention in these studies.

The method of investigation is otherwise not changed from our routine examination. The patient is given, without any further preparation, first a barium water, then a barium milk suspension (recently malted milk), seldom with the stomach empty and often after mixed meals containing even fried pota-

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toes, as well as other varieties of food. It is very seldom necessary for the patient to take cathartics, a practice which we discourage during examinations. Some of our patients had been starving for twelve hours, but longer starvation periods were not sought, though Alvarez mentions starvation as causing a lowering of gastric tone and so permitting duodenal regurgitation.

The examinations have been carried on for a full year and the observations on all patients were noted. We have remarked upon the same discrepancy which Alvarez noted when he said: "If reverse peristalsis is so common, why do we not see more of it?" In this series of 190 cases examined from August, 1921, to October, 1922, we have encountered duodenal regurgitation only nine times, 4.7 per cent, and since it is on one hand a normal occurrence, but on the other a rare roentgenological observation, it is questionable whether its occurrence has been correctly estimated.

The clinical significance of duodenal regurgitation is not yet understood, but we do know that it is effected by the contents of the duodenal cap flowing back into the stomach. Whether this takes place through increased intraduodenal pressure, "ring like constrictions" (similar to those described by Carmen in the discussion of stomach emptying, in his second edition) or some other modus is yet to be determined. That the presence of hyper-peristalsis in the stomach has no lessening effect on regurgitation is shown by a recently studied case of obstructive duodenal ulcer with a very large stomach containing a good sized six hour residue. Here it was seen very definitely that the gastric contents were driven back across the empty pouch, in the supine posture, into the body of the stomach by the deep, slow moving waves, yet at the same time duodenal regurgitation was seen to take place quite frequently. Later, it occurred to me that the back flowing gastric contents possibly exerted suction on the duodenal contents in the cap, while the pylorus was open and the contracting cap drove the contents back into the stomach. How often this happens normally has yet to be determined.

The amount regurgitated at a time may be very small, but, as one case taught us, the total may be quite a good deal. In this instance, the stomach was two-thirds empty at the end of three hours and nearly full again at the six hour period. Besides, the patient vomited repeatedly during this time, so that the stomach contents were only a part of the total amount regurgitated.

In spite of its small amount, duodenal regurgitation must be considered as a contributing factor in gastric retention, when seen in cases without organic obstruction at the pylorus, even though the gastric residue may be primarily due to either delayed or infrequent pyloric opening, prolonged or continuous spasm or lowered intragastric or lowered intraabdominal pressure, so-called atony.

The conditions under which we find duodenal regurgitation are quite varied. In the case of duodenal ulcer, previously mentioned, the diagnosis of which was verified at operation, and likewise in a case of presumptive pyloric ulcer with a large ten hour residue, which has not yet come to operation, duodenal regurgitation was noted. In the last named case the pylorus opened promtply and regularly, but the regurgitation was so complete as to leave the duodenum quite empty at the end of the first half hour. In this, as well as all other cases in which duodenal regurgitation was observed, it was found to occur throughout the whole period of gastric digestion.

Recently I noticed regurgitation in a case of duodenal obstruction. This obstruction was situated at the dependant portion of the descending part of the duodenum and was best seen with the patient standing. Regurgitation, both from the point of obstruction to the cap and from the cap into the stomach was noted and was continuously present during the entire time of observation, in the beginning, as well as toward the end of digestion, but less marked with the patient in the horizontal position. A kink was possibly caused either by adhesions from the gall-bladder region or by traction from the ileocecal region, there was a chronic appendicitis. Therefore mechanical as well as chemical agents must be factors in its occurrence.

In another case, that of a child, duodenal regurgitation was observed under great emotional stress, the nervousness of the parents frightening the child who was subject to epileptic fits. This child at first absolutely refused to take the barium water and was induced to do so only with the greatest difficulty.

In a boy of twelve, duodenal regurgitation followed immediately on the intake of the barium and the duodenum remained empty for the following half hour. A few days later this boy developed jaundice, which cleared up under medical treatment. In this connection it is well to remember Alvarez' warning that "as the presence of bile in the stomach is normal, any excess need not indicate disease of the liver so much as an increase in the normal duodenal regurgitation."

The absence of regurgitation is especially noticeable in cases of diseased gall-bladder where one would expect to find it according to the patient's complaints, and where clinicians maintain it is detected in their examination. In only one case of gall stones verified at operation was duodenal regurgitation found to occur. It was likewise found to be absent in a recent case of cirrhosis of the liver in an alcoholic, although he gave a history of daily vomiting.

In four gastro-enterostomies duodenal regurgitation was not observed at the ostium, although regurgitation in the duodenum from the ostium to the pyloric sphincter and back into the

Drawings illustrating duodenal regurgitation as seen by the x-rays.

stomach has formerly been a common roentgenological observation. In the cases mentioned, however, a pylorectomy was done. We observed that as soon as the proximal loops of the jejunum were filled, the artificial opening closed like a sphincter and thereafter opened only at regular intervals and without a sign of regurgitation.

In acute postoperative distension, the giving of barium by mouth is not advisable; therefore, probably the most common occurrence of duodenal regurgitation cannot be studied. It must also occur with a patient awakening from an anesthetic and vomiting bile. Animal experimentation combined with screen study might be tried successfully.

Gastric lavage, or better, the forcing of the gastric contents up through a stomach tube by abdominal pressure, has yielded in the past the main clinical evidence of regurgitation bile and pancreatic ferment in the stomach. But how was it known that its presence was due to normal duodenal regurgitation or to irritation from the tube? In some patients, retching while passing the tube, and in others its irritation of the gastric mucosa may possibly have brought on duodenal regurgitation which otherwise was not normally present. With the Einhorn duodenal tube or the later perfected Reyfuss tube in the duodenum, the pyloric sphincter is constantly open and does not hold the tube firmly. It is easily withdrawn, as control under the fluoroscopic screen has taught us. Therefore, a backflow along the tube is easily possible.

Clinically, we have the patient's word that he lacks appetite, has a constant flat or bitter taste and occasionally brings up bile stained contents. This fluid may be yellow or green in color, but chemical tests are necessary to verify its being bile. A quick, reliable method is the adding of a few drops of iodine to ether and mixing this with the vomitus. The ether will quickly stain green if bile is present. The vomitus following an abdominal operation is often green, but this does not always signify bile. It is often due to a green algus, as my former associate in Chicago, Dr. Leopold Fraenkel, discovered.

We rarely subject the patient to gastric analysis, because the value of the clinical data thereby obtained is in no proportion to the disagreeable features of the procedure and therefore the relationship of the acid values of the stomach contents to the frequency of duodenal regurgitation has not been determined. The only case treated on in this paper and checked in the labaratory was that of the cirrhosis of the liver, mentioned previously. Here the gastric contents showed no free hydrochloric nor lactic acids and no visible bile. Microscopically it was negative.

As any manipulation of the intestines may start the gradients of irritation traversing both ways, palpation was repeatedly tried in order to induce duodenal regurgitation, but without success. Palpation and pressure often helped to open a closed pyloric sphincter, but it was never possible to force duodenal contents back into the stomach. Case and Groedel's pioneer work on the ileocecal valve was in my mind when I tried to obtain this artificial regurgitation.

Animal experimentation has taught us most of what we know of duodenal regurgitation, and we must look to such men as Alvarez and Carlson for further enlightenment. In the meantime we roentgenologists need not be idle, but should help by contributing the information which we have, as it may be of value in explaining the significance of this interesting phenomenon.

In every case where I observed duodenal regurgitation, I had my associate, Dr. Frances MacCraken, verify my findings; and we were often both misled. The course of the duodenum is frequently hidden behind the stomach, and in many patients even turning the body did not lead to any conclusive demonstration of duodenal regurgitation. Often observations made in the upright failed to concur with those made in the supine and prone positions, but where duodenal regurgitation is reported as observed, it was seen in all postures. Therefore, we roentgenologists may confine ourselves to fluoroscopic screen observations, which are apparently just as reliable as the other clinical tests.

The x-ray examination for duodenal regurgitation should be made at either the three hour residue period, or if the stomach is not empty, at the six hour period.

In each of the nine cases in which duodenal regurgitation was observed I might almost say there was a different pathology present, so that as yet we are unable to surmise beforehand when to expect this phenomenon. On the other hand, its rare occurrence may speak for some mechanical or chemical or neurological disturbance at the pyloric sphincter, in spite of its appearing normally under experimental conditions. What value its recording may have, can be estimated only after many observations by a large number of investigators.

It would also be well to study its occurrence with the patient drugged with morphia and belladonna, and even the opportunity to observe it in alcoholism should not be unobtainable.

In conclusion, I would say that duodenal regurgitation, although occurring undoubtedly under normal conditions, is nevertheless rarely observed by the roentgenologist, and this discrepancy may throw some light on its clinical significance. Only in rare instances may it fully explain gastric retention, in most of these it is only a contributing factor along with the delayed phyloric opening and prolonged pyloric spasm or gastric atony.

X-Rays and X-Ray Apparatus; An Elementary Course*

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THE PENETRATING EFFECT OF X-RAY

VII.

General Properties of X-Ray

76. Without entering at present into a discussion regarding the nature of x-rays, we shall note certain general properties.

(1) *Photographic*—They effect a photographic plate or film in much the same way as ordinary light. The speeds of different makes vary and, for the same plate, the speed varies with the kind of rays used.

(2) *Fluorescent*—X-rays excite fluorescence in certain substances on which they fall. By fluorescence we mean the emission of visible light which continues as long as the x-rays strike the substance. Two applications of this property are made in roentgenology, the first in the use of a fluorescent screen for diagnostic work, the second in the use of intensifying screens for shortening exposures when radiographs are being made. Intensifying screens, which are made of substances such as tungstate of calcium, are placed directly in contact with the sensitive emulsion on the photographic plate or film. Wherever the rays strike the screen, therefore, the bluish (fluorescent) light emitted (which is much more actinic than x-rays) acts on the emulsion and so shortens the exposure to a marked degree. A reduction as much as five to ten-fold is quite normal. Care must be taken to keep the screen clean, for particles of dust will absorb the visible fluorescent light and spot the plate. The exposure may be still further shortened by using films sensitized on both sides along with intensifying screens on each side of the film. "In actual use intensifying screens are mounted in rigid holders called cassettes, in order that perfect contact may be obtained between emulsion and screen" (Eastman Kodak Co.).

In the Impex x-ray photographic plate[1] we have an illustration of an application of the same principle. In this plate still further reduction in the time of exposure is obtained by spreading the tungsate of calcium on the plate itself in a layer directly over the sensitive emulson. By so doing, the fluorescent substances are so much more effective that reductions of the magnitude of twenty-five to thirty-fold are obtained. In using the Impex plate the only difference from the procedure with the ordinary plate lies in the necessity of washing off the fluorescent substance immediately before development.

(3) *Chemical and Dehydrating Effects*—X-rays produce a discoloration of certain alkaline salts, liberate iodine from a solution of iodoform in chloroform, and change the color of certain substances such as barium platinocyanide.

(4) *Physiological*—The burns which result from undue exposure of the skin to x-rays, the beneficial effect of the rays on certain skin diseases, the stunting of the growth of young animals, are a few of the many examples of this important property, some further details in connection with which will be considered later.

(5) *Ionization*—X-rays make the air through which they pass conducting, as may readily be shown by placing a charged electroscope almost anywhere near a tube. On sending a current through the tube, it is at once observed that the leaf of the electroscope steadily falls until the whole charge has disappeared. The rays have ionized the air in the neighborhood of the electroscope to an extent which at any given region is proportional to the rate at which the leaf falls. Should the simple experiment be repeated a number of times, each time placing the electroscope at a greater distance from the tube, it would be found that the leaf falls more slowly the further it is removed from the tube. This indicates that the ionization at a local region, and so the intensity of the beam of x-rays is greater, the nearer the region is to the tube.

As the ionization property is the basis of the most accurate methods of estimating dosage when x-rays are used for treatment, the importance of this property cannot be too strongly emphasized. Later, details of suitable ionization chambers will be given; at this place, however, a simple form of electroscope which the writer has found useful in lecture experiments, may be noted (Fig. 76). The leaf is attached to the usual metal support, which however is supported by means of the insulating bead of sulphur S. The whole is enclosed in an earthed metal chamber in one side of which is a window W covered with very thin metal foil. The electroscope is charged by means of a movable rod R which passes through an insulating support to the outside of the box.

(6) *Penetrating Effect*—There are few people nowadays who are not familiar with the fact that x-rays pass through fairly thick sheets of matter which we ordinarily call opaque. A thin piece of wood is almost as transparent to x-rays as window glass is to sunlight. But thin layers of any substance are more transparent than thick, and some substances more opaque than others, and herein lies the basis of the familiar x-ray pictures. Radiographs are just shadow pictures, wherein detail is visible because of the unequal degree to which different parts of the subject photographed absorb x-rays. There are in consequence corresponding differences in density on the plate or film. As the whole application of x-rays both for radiography, and for treatment is bound up with the question of absorption of x-rays, the question of penetrating power will now be considered in detail.

77. It is first of all important to realize that the terms opacity, or opaqueness, or transparency, of a substance to x-rays are very indefinite. An experimental illustration will make the point clearer. Before the window of a charged electroscope (Fig. 76) is hung a sheet of so-called protective rubber. On placing a small x-ray tube a short distance away with target pointing towards the window of the electroscope, it is found that, when the tube is running on moderate voltage, the leaf of the electroscope remains stationary or falls extremely slowly. On using a larger tube, however, operated at higher voltage, the leaf falls in a matter of a few seconds. The rubber is opaque to the first beam of x-ray, but far from it to the second. In other words, x-rays from some tubes are more penetrating than from others.

78. Again, the same bulb when operated under different conditions emits rays which have different penetrating effects. Suppose a Coolidge tube is used, with always the same milliamperage, but at a series of different voltages. Suppose, further, that, for each voltage, the distance of the tube from the electroscope is adjusted so that in each case the leaf falls at the same rate, when the sheet of rubber is absent. If now another set of readings is taken for each voltage, with corresponding distances, with the rubber sheet interposed, it is found that the

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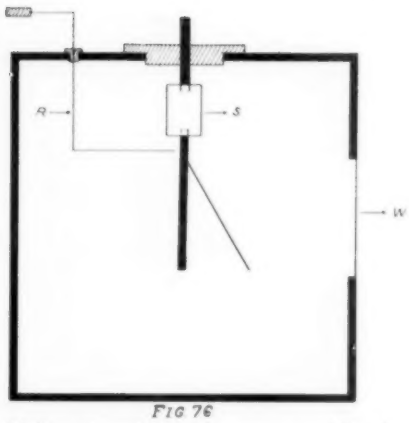

FIG 76

higher the voltage the more rapidly the leaf falls. The conclusion is obvious—the higher the voltage across a tube, the more penetrating the rays emitted.

There are, therefore, different kinds of x-rays which we may describe as *hard, medium, or soft*, according as they are very penetrating, moderately penetrating or feebly penetrating. It will be recalled (Sec. 49) that the same terms are used to describe the state of a gas tube, a hard tube being one in which a higher voltage is required to maintain a certain current than is the case with a soft one. But there is no confusion of terms, for we have just seen that a higher voltage across a tube means an increase in the penetrating power of the rays emitted. A hard tube, therefore, emits an excess of hard rays, a soft tube, an excess of soft rays. But the terms hard, medium and soft are much too elastic for the accurate measurement of so important a quantity as the penetrating power and we must seek some means of expressing degrees of hardness by definite numbers. In other words, we need a scale in terms of which the quality of a beam of x-rays may be expressed.

Means of Measuring Quality

79. Four different methods may be used: (1) Method I, involving a measurement of the voltage across the tube; (2) Method II, in which (a) it is necessary to determine the thickness of some standard substance required to reduce the intensity of a beam by 50 per cent, or (b) the intensity of a beam is measured before and after the insertion of a standard thickness of a standard substance; (3) Method III, in which the absorption of rays by two different metals is compared; (4) Method IV, by the direct measurement of the wave-lengths in the beam or of the so-called "effective" wave-length. Each of these methods will be considered in turn.

Hardness by Spark Gap and Bauer Qualimeter

80. Since, as we have pointed out, the penetration increases with the voltage across a tube, the length of the equivalent spark gap may be taken as a measure of the degree of hardness of the rays leaving a tube. The longer the gap, the harder the rays (see Table XIV).

In the Bauer Qualimeter, we find a practical instrument which utilizes this same principle. It is an electrostatic voltmeter which is used somewhat like the voltmeter described in Section 19, and therefore may be placed at any convenient place in the x-ray room. The instrument consists essentially of two fixed plates between which two vanes are free to move. As the higher the potential, the greater the deflection of the movable vanes, this deflection is taken as a measure of the hardness of the rays leaving the tube. A pointer attached to the vanes moves over a scale from which the hardness is read, not in "inches or centimeters of spark-gap," but in a purely *arbitrary* scale with numbers running from 1 to 10. Number 1 indicates a penetration such that the corresponding rays are completely absorbed by 0.1 mm. of lead, number 2 by 0.2 mm. of lead, and so on until we reach number 10 indicating rays completely absorbed by 1 mm. of lead. Numbers 4, 5 and 6 correspond to medium rays, smaller numbers to soft, higher to hard rays.

In the Bauer Qualimeter, therefore, we have the first kind of *penetrometer* which has been used to express the degree of penetration by a definite number. Its usefulness, however, is limited for several reasons: (a) Two bulbs, with exactly the same back-up, will not always emit rays of the same degree of hardness. (b) Again, the hardness of what are called characteristic x-rays (to be discussed later) does not increase steadily with the applied potential. (c) Layers of some absorbing substance are frequently placed between the tube and the place "treated," and these filters, as they are called, alter the mean quality of the rays. It is desirable, therefore, to use more direct means of measuring the penetration, such as we have in Method II.

81. To use this method, layers of increasing thickness of some standard substance are interposed between the x-ray tube and some measuring instrument such as the electroscope, and the particular thickness determined which reduces the intensity of the beam exactly 50 per cent. This thickness, which is called the *Half Absorption Value*, is clearly a measure of the hardness of the rays. The choice of a suitable substance depends on several factors, but for work in radiology it is decidedly advantageous to use a substance whose absorption can be compared with that of body tissue. For that reason aluminum, water, and bakelit[2] have been used, although it will be seen directly that aluminum is not satisfactory from this point of view. Here we may digress to ask,

What is the Most Suitable Phantom?

82. A partial answer to that question is found in the work of Kroenig and Friedrich[3] from whose book the measurements given in Tables IX, X XI and XII have been taken.

TABLE IX.

Quality of Rays	Absorption in 5 cm. water	Absorption in 5 cm. meat
I.	80.6 per cent	81.6 per cent
II.	68.4 per cent	70.0 per cent
III.	63.4 per cent	65.4 per cent
IV.	57.7 per cent	59.5 per cent

To compare water with tissue, the extent to which the intensity of four different kinds of x-rays was reduced by a thickness of 5 cm. of water was compared with the reduction by 5 cm. of ground meat. The results are given in Table IX, where I, II, III and IV refer to rays of increasing hardness. It will be seen, for all four of these different kinds of rays, water absorbs within one or two per cent, to the same extent as tissue. In Table X, where a, b, c, d and e refer to rays of increasing hardness, similar measurements are given for water and aluminum.

TABLE X.

Quality	5 cm. water	5 cm. aluminum
a	82.7 per cent	75.1 per cent
b	81.1 per cent	70.2 per cent
c	71.8 per cent	53.4 per cent
d	62.4 per cent	37.3 per cent
e	58.7 per cent	28.2 per cent

In this case, it will be seen that while for the softer rays (class a), aluminum absorbs to nearly the same extent as water, in the case of the most penetrating rays (class e), it is very much more transparent. Now as water has been shown to be a good phantom for tissue for all kinds of rays, it is evident that aluminum is not, especially for very hard rays.

Hardness by Half Thickness Method

83. We return now to a consideration of the second method of measuring penetrating power, the method in which it is necessary to determine the

half absorption thickness D of some standard substance. In Table XI is

TABLE XI.

Thickness of Aluminum	Intensity of Radiation
0	100
1	68.6
2	51.3
3	39.9
4	32.4
5	29.0
6	25.4
7	21.7
8	19.4
9	16.8
10	15.0

given a typical set of readings showing the gradual reduction in the intensity of a beam of x-rays when layers of aluminum of increasing thickness are interposed between the tube and the measuring instrument (such as electroscope). From this table, or the corresponding graph given in Figure 77 it is easy to find out that the value of D, the thickness necessary to reduce the intensity from 100 units to 50 units is 2.15 mm. But if we attempt to describe the quality of the rays leaving this tube by stating that their half absorption value is equal to 2.15 mm. of aluminum, we encounter a difficulty. The same table (or graph) shows that the thickness necessary to reduce the intensity from 50 to 25 units, that is a second 50 per cent, is not 2.15 mm., as might be expected, but 4.32 mm. Evidently the penetrating power of the rays after having transversed the first few layers has increased. The conclusion is obvious—the original beam must have contained a mixture of rays, some more penetrating than others. The first absorbing layers therefore removed a greater percentage of the softer, less penetrating rays, thus transmitting a beam with an excess of harder rays. Now, the same can be shown with reference to the beam of x-rays leaving any tube—there is always a mixture of both hard and soft rays. Stepping up the voltage increases the average penetrating power, but there are always soft rays present.

Filters

84. Because of the fact which has been emphasized in the previous section, it is often necessary to get rid of the softer components. Suppose, for example, deep-seated tissue were being treated with x-rays which of necessity would have to be very penetrating. In such a case the soft rays present would be almost completely absorbed by the skin and intervening tissue, and more harm than good might be done. To remove the soft rays, filters are used, that is, layers of some substance placed between the tube and the place treated. For protecting the skin from very feeble rays, substances such as aluminum, paper, tanned leather, chamois leather, felt, lead acetate lint and sodium acetate lint, are sometimes used. Metallic filters of greater absorption are also used, when it is desired to obtain a beam of fairly homogeneous hard rays. The effect of filters for this purpose will be clear from an inspection of Table XII.

TABLE XII.

Quality	Filter	D for first 50 per cent	D for second 50 per cent
1	None	1.8 cm.	2.25 cm.
2	3 mm. Al	2.4 cm.	2.65 cm.
3	10 mm. Al	3.25 cm.	3.30 cm.
4	1 mm. Cu	3.7 cm.	3.75 cm.

This table gives the thickness of water necessary to reduce the intensity of four different beams of x-rays of increasing hardness; (1) from 100 to 50 units, (2) from 50 to 25 units, with different conditions of filtration. The table shows that rays which have been filtered with 10 mm. of aluminum or still better, 1 mm. of copper, are fairly homogeneous, that is, successive reductions in intensity *of equal amounts* are produced *by equal thicknesses* of an absorbing medium. Such filters completely absorb the softer components.

In such cases the value of D is a fairly accurate measure of the quality of the rays utilized. Even in the case of rays which are far from homogeneous, the half absorption value gives a good idea of the average penetrating power of the beam. For example, rays which have a value of D from 10 to 15 mm. of aluminum are of average hardness; values considerably greater correspond to very hard rays, considerably less to very soft. Thus, if the same absorbing medium is always used, the values of D obtained for different beams of rays provide a set of numbers for comparing their average penetrating powers. The larger D, the more penetrating the rays.

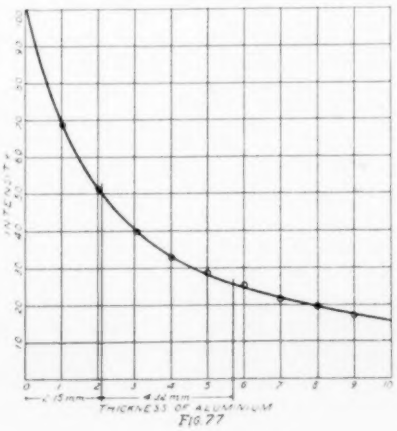

FIG. 77

The Christen Penetrometer

85. It is not always necessary, however, actually to have an ionization instrument and to make intensity measurements similar to those given in Table XI. There are other types of penetrometers for enabling an operator in a very few minutes to obtain at least an approximate value of the penetration. In the Christen penetrometer, for example, the quality is expressed in terms of the half thickness value of bakelit. The beam whose penetration is to be measured falls on a fluorescent screen, after one portion has passed through a perforated lead plate, and another through a bakelit step ladder (wedge). The lead plate contains small holes of such an area that the intensity of the beam is reduced exactly one-half. In actual use a reading is taken of the particular thickness of the bakelit wedge behind which the intensity of the fluorescent light is the same as that behind the lead plate. Obviously this is the required half absorption value, and the quality is at once expressed in terms of this thickness.

A brief reference will now be made to a few other penetrometers, in all of which penetration is measured by means of the third method, that is, by a comparison of the absorption of different metals.

The Benoist Penetrometer

86. This consists (Fig. 78) of a disc about an inch or more in diameter, with a central ring of thin silver, 0.11 mm. thick, surrounded by 10 or 12 sectors of aluminum with thicknesses ranging from 1 mm. to 10 or 12 mm. The general appearance is somewhat like that of a spiral staircase. In actual use, the penetrometer is placed directly over a photographic plate. As each section of the corresponding image obtained on development is blackened an amount which depends on the extent to which rays are absorbed, there is one sector whose image shows the same shade or degree of blackening as that behind the silver center. Should the rays be made more penetrating, a thicker sector would have the same shade. Fig. 79 is a reproduction of an actual photograph, for the use of which my thanks are due Dr. W. D. Coolidge. As the number of the sector which shows the same shade as the inner circle is taken as a measure of the penetrating power, we are provided with another arbitrary

scale of quality, Benoist 1, 2, 3 to 10 or 12. Benoist, number 6 (B-6) for example, corresponds to a medium degree of hardness. This penetrometer depends on the principle that silver absorbs strongly practically all kinds of x-rays used in radiology.

Fig. 78—Benoist Penetrometer (Wappler Elec. Co.)

The Walter Radiometer

87. This consists essentially of a sheet of lead, perforated with eight holes, each of which is covered with a sheet of platinum, and the whole backed with a fluorescent screen. As the thicknesses of the pieces of platinum vary in geometrical progression from .005 mm. for hole No. 1 to .64 mm. for hole No. 8, the more penetrating the rays the greater will be the number of fluorescent spots observed on the screen.

The degree of hardness is therefore measured by the number of the hole corresponding to the greatest thickness of platinum penetrated.

The Wehnelt Crypto-Radiometer

88. In principle this is similar to the Benoist Penetrometer. Behind a lead plate with a vertical slit is placed a fluorescent screen. In front of the slit is placed a flat strip of silver and a wedge shaped strip of aluminum, both of which may be slid along in a horizontal direction. Rays falling on this radiometer pass through the silver and the aluminum, thus causing the screen behind the vertical slit to fluoresce. The penetration is measured in terms of the thickness of the aluminum wedge behind which the intensity of fluorescence is equal to that behind the silver.

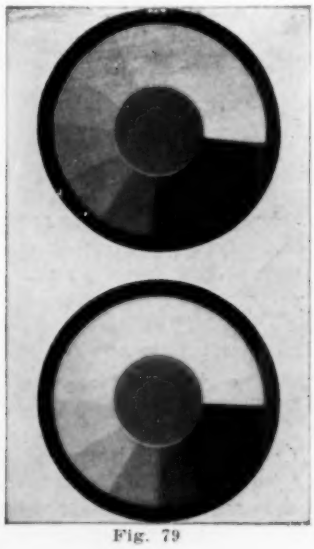

Fig. 79

89. As the use of both the Walter and the Wehnelt penetrometers depends on visual observation of a fluorescent screen, it should be evident that care should be exercised that the lead plate provides ample protection for the observer. (See Sec. 91).

Comparative Values of Various Penetrometers

90. As in the different means of measuring penetration which we have been discussing, purely arbitrary scales are used, it is highly important to be able to compare one scale with another. For example, in the Wehnelt scale, what corresponds to Benoist 7? The answer will be found in Tables XIII and XIV, in which comparative values are given, one set after Knox, the other after Christen.

TABLE XIII.

Table of comparative values of various penetrometers (after Knox)

	Soft				Medium					Hard
Bauer	1	2	3	4	5	6	7	8	9	10
Kehnelt	1.5	3	4.5	6	7.5	9	10.5	12	13.5	15
Walter	1	1–2	2–3	3–4	4–5	5–6	6–7	7–8	....	..
Benoist	1	2	3	4	5	6	7	8	9	10

TABLE XIV.

Table of comparative values of various penetrometers (after Christen)

Half-Value Layer in cm.	Wehnelt	Benoist	Walter	Bauer	Spark gap in cm.
0.2	1.7	1	–	1.1	1–4
0.4	3.2	3	4	2.2	3–6
0.6	4.8	4	5	3.2	5–10
0.8	6.2	4	5	4.1	6–12
1.0	7.5	5	6	5.0	7–15
1.2	8.8	6	7	5.8	8–18
1.4	9.8	7	8	6.5	12–25
1.6	10.6	8	8	7.1	———
1.8	11.3	8	–	7.5	———
2	11.9	9	–	7.9	———

Protection

91. Before discussing the fourth method of measuring penetration, we shall digress again briefly to discuss the subject of protection. We have seen that with increasing voltage goes an increase in the penetration of the rays emitted by a tube. In other words, as we have already noted, a substance may be absolutely opaque to rays from a tube on low voltage, and comparatively transparent when much higher potentials are utilized. With the high voltage machines now available, it is possible to obtain x-rays which will penetrate 4 to 5 mm. of lead, or 7.5 cm. of steel or iron. Indeed we have an industrial application in the use of x-rays to detect the presence of flaws in steel plates, copper castings, etc. It follows, therefore, that with the increasing use of higher voltages, both in industry and in radiology, the importance of exercising the utmost care to guard against undue exposure to x-rays cannot be too strongly emphasized. The penalty which so many pioneer workers had to pay for (in their case) excusable ignorance of the dangers, should be a warning to all beginners in x-ray work.

Protection is necessary not only because of danger of burns and allied troubles resulting from undue exposure to the rays, but also because of the danger of contact with high tension wires and apparatus, as well as from noxious fumes developed in the x-ray room. What some of the necessary precautions are, may best be given by quoting from the report of the x-ray and radium protection committee of Great Britain. [4, 5].

Ventilation

"1. It is strongly recommended that the x-ray department should not be below the ground level.

"2. The importance of adequate ventilation in both operating and dark rooms is supreme. Artificial ventilation is recommended in most cases. With very high potentials coronal discharges are difficult to avoid, and these produce ozone and nitrous fumes, both of which are prejudicial to the operator. Dark rooms should be capable of being readily opened up to sunshine and fresh air when not in use. The walls and ceilings of dark rooms are best painted some more cheerful hue than black."

Electrical Precautions

"The following recommendations are made:

"1. Wooden, cork, or rubber floors should be provided; existing concrete floors should be covered with one of the above materials.

"2. Stout metal tubes or rods should, wherever possible, be used instead of wires for conductors. Thickly insulated wire is preferable to bare wire. Slack or looped wires are to be avoided.

"3. All metal parts of the apparatus and room to be efficiently earthed.

"4. All main and supply switches should be very distinctly indicated. Wherever possible double-pole switches should be used in preference to single-pole. Fuses no heavier than necessary for the purpose in hand should be used. Unemployed leads to the high tension generator should not be permitted."

Deep Therapy

"This section refers to sets of apparatus giving voltages above 100,000.

"1. Small cubicles are not recommended.

"2. A large, lofty, well ventilated and lighted room to be provided.

"3. The x-ray bulb to be enclosed as completely as possible with protective material equivalent to not less than 3 mm. of lead.

"4. A separate enclosure to be provided for the operator, situated as far as possible from the x-ray bulb. All controls to be within this enclosure, the walls and windows of which to be of material equivalent to not less than 3 mm. of lead."

Full details will be found in the original report.

Where transparency (for visual observation) or flexibility is required, sheets of lead glass or of rubber impregnated with lead may replace lead itself. Such sheets should be considerably thicker than the corresponding minimum layers of lead; in the case of good rubber, from 2 to 4 times as thick, in the case of glass from 5 to 10. Different specimens vary considerably however. Ultimately it is probable that such material will have to be sold with the standardization mark of the Bureau of Standards, or, in England, of the National Physical Laboratory. It should not be forgotten, too, that rubber deteriorates with age, and should be renewed periodically.

The x-ray tube itself should always be covered with protective material except for a small opening through which the beam to be utilized can pass. In addition to the permanent protective shield usually found about a bulb, an extra protective layer of rubber as recently described by Pfahler[6] may well be used.

Penetration and Wave Length

92. The most exact way of describing the quality of a beam of x-rays is found in the fourth method, that is, by giving the wave length or the effective wave-length of the beam utilized. Before this method can be discussed, however, it is necessary to say something about the nature of x-rays.

VIII.

The Nature of X-Rays

93. For many years after their discovery, the exact nature of x-rays was a subject about which there was much speculation. Until 1912 there was ample justification for naming them by the third last letter in the alphabet. In that year, however, as a result of the work of Laue, assisted by Friedrich and Knipping, it was experimentally demonstrated that the phenomenon of interference could be obtained with x-rays, and that consequently they were a form of wave-motion. As the pioneer work of these men opened up a field of research which has led to tremendous advances in our knowledge both of x-rays and of other physical phenomena, it is desirable that all x-ray workers should clearly understand the fundamental ideas of wave-motion.

Everyone is familiar with water waves, as well as with the fact that they may be big, or very "tiny" as in the case of what we ordinarily call ripples. An observer watching water

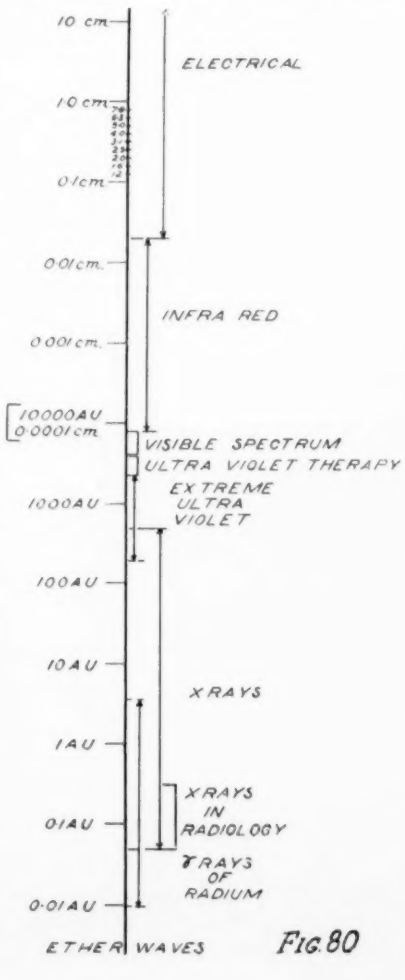

FIG. 80

waves at all carefully cannot fail to be struck with two things, (1) crests and troughs repeat at regular intervals, (2) at any place at which he may fix his attention, the water goes through a to and fro motion; a floating block of wood bobs up and down, up and down, and so on. Now, these two features are characteristic of any regular train of waves. At any given instant (imagine a snap-shot photograph taken) the position of particles is repeated at regular intervals, which we call wave-lengths. A wave-length, therefore, is the distance between successive particles whose displacement and velocity with reference to their normal position is the same, or to use the technical phrase, two particles which are in the same phase. In the case of water-waves, from crest to crest, or trough to trough, is a wave-length. On the other hand, if we fix our attention on the particles at any particular place, we see that each particle at regular *time* intervals, comes back to the same position. This time interval is what is called the *periodic* time or briefly the period, although more often we speak of the *frequency* or the number of complete to and fro vibrations per second.

It is not a difficult matter to prove that the wave-length is just the distance the wave disturbance travels during the time of one complete vibration of a particle.

94. In sound waves we have exactly the same phenomena. As a train of sound waves travels along, the air particles at all places go through a to and fro motion. If we could take a snap-shot of the air, we should be able to see that certain particles, separated by regular intervals, are displaced exactly the same amount from their normal position. Should we take a set of tuning forks all of which vibrate at different rates we should observe something else, and that is, that the wave-length is shorter, the more rapidly a fork is vibrating. Now, everyone knows that a person listening to such a set of tuning forks would hear for each one, a characteristic note of a musical scale. From what has just been stated, however, it should be evident that physically we can describe the different notes by giving either the frequency of the fork (number of vibrations per second) or the wave-length emitted. The higher the pitch of the note, the higher the frequency, the shorter the wave-length. In sound usually we make use of frequency, but it is important to realize that we might describe different notes in terms of corresponding wave-lengths.

95. In ordinary (visible) light we have another important example of wave-motion. In this case, the medium

in which the vibrations take place is the invisible "luminiferous" ether. To visualize what is going on, one may think of vibrations of ether "particles," or may make use of the modern conception that light waves are electromagnetic in character. On this point of view, when a train of light waves passes along there is (1) at any place, a periodic change in the electric and magnetic intensity, while (2) at any instant (compare the snap-shot above) the values of the electric and magnetic intensity repeat at regular intervals, which we call the wave-length. Moreover, just as in sound we have different frequencies and wave-length, so in light we have different colours. These also we describe physically in terms of corresponding frequencies or wave-lengths. Although it is not always the case, in light it is more usual to use wave-lengths. To come to definite numbers, when waves of lengths ranging from approximately 0.00007 cm. to 0.00006 cm. fall on the eye, the sensation of red results. Physically, wave-length 0.000068 cm. is not the same red as, say 0.000065 cm., but the eye probably would not be able to detect any difference. Wave-lengths in the neighborhood of 0.000058 cm. correspond to yellow, and so on down through the ordinary spectrum until we come to violet, corresponding to wave-lengths a little greater than 0.000040 cm.

96. But light-waves are not the only ether waves with which we have to deal. There are waves longer than the longest red, and shorter than the shortest violet. On the long side we have first of all what is called the infra-red region, comprising wave-lengths ranging from 0.00007 cm. to .031 cm. These waves, at least the shorter of them, are sometimes called heat waves because on absorption by a body on which they fall, they give rise to a considerable amount of heat. The name, however, is not a happy one, as shorter waves also on absorption give rise to heat.

Next we have the still longer electrical waves which have lengths nearly[7] as short as the longest infra-red, and as long as those used in wireless. In "Radio," for example, wave-lengths of the order of several hundred metres are used, while we may have electric waves even miles in length.

97. Turning to the other end of the spectrum, we find first of all the ultra-violet region comprising waves which, but a few years ago, ended at 0.00001 cm., but which in the last year or two have been obtained as short as 0.000002 cm. In ultraviolet therapy use is made of the waves in this region from approximately 0.00004 cm. to 0.00002 cm. (For information regarding this field of work, readers are referred to the series of articles recently published in this Journal by Dr. A. J. Pacini).[8] In passing we may note that these short waves are very easily absorbed by matter, a thickness as small as 1 mm. of air at atmospheric pressure absorbing beyond 0.000017 cm. For the measurement of the extremely short waves in this region apparatus with air at very low pressure must be used. Glass itself is transparent only to waves a little beyond the visible violet, and for that reason, quartz (opaque beyond .0000185 cm.) must be used in lamps designated for their ultraviolet output.

Coming to x-rays, we have seen that the work of Laue, Friedrich and Knipping showed that these also are ether waves, usually of wave-lengths much shorter than even the shortest ultraviolet. While the complete range extends from 0.000005 cm. to 0.0000000006 cm., in radiology, the rays utilized have lengths ranging from 0.000000003 to 0.0000000006 cm. Finally we have gamma rays of radium, the shortest known ether waves, with wave-lengths ranging from 0.000000014 to 0.0000000001 cm.

The Angstrom

98. Because of the extreme shortness of both visible and invisible light waves, another unit of length is generally used. This new unit, which is called the Angstrom, is simply 10^{-8} cm., that is, one hundred-millionth of a centimeter. Thus, instead of writing 0.00006 cm., we write 6000 angstroms or 6000 A.U., and the range of wave-lengths used in radiology extends from 0.3 A.U. to 0.06 A.U. Table XV gives a summary of all classes of ether waves with approximate limits, while Figure 80 shows graphically (logarithmic scale) the complete range. It should be clearly understood that, although one class is called electrical, all these waves are of the same character, all electromagnetic. Differences in their properties correspond solely to differences in their wave-lengths. In the next article questions of penetration and wave-length will be discussed and a brief reference will be made to the method of measuring x-ray wave-lengths.

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2. Bakelit is an insulating material made by hot pressing paper or cloth with raw bakelit, a condensation product of carbolic acid and formaldehyde.

3. The Principles of Physics and Biology of Radiation Therapy, Kroenig & Friedrich, English Edition by Schmitz, Rebman, New York, 1922.

4. Preliminary Report of the X-Ray and Radium Protection Committee in England.

5. Report of the above report included in "Protection in Radiology" by Pfahler, Am. J. Roentgenol., 9:803, Dec., 1922. Abstract of in I. Radiol., 4:96, March, 1923.

6. Am. J. Roentgenol., 8:5, May, 1921.

7. The writer understands that as the result of some recent work not yet published the gap between the electrical and the infra-red region has been bridged.

8. J. Radiol., 3:378, Sept. & 481, Nov., 1922.

TABLE XV.

	Range of Wave Lengths
Electrical	10^{6} cm. to 0.08 cm.
Infra-red	0.031 cm. to 0.00007 cm.
Visible	(0.00007 cm. — 0.00004 cm.) (7000 A.U. — 4000 A.U.)
Ultraviolet in Therapy	4000 A.U. — 2000 A.U.
Extreme Ultraviolet	4000 A.U. — 200 A.U.
X-Rays	500 A.U. — 0.06 A.U.
X-Rays in Radiology	0.3 A.U. — 0.06 A.U.
Gamma Rays of Radium	1.4 A.U. — 0.01 A.U.

EDITORIAL

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ANNUAL MEETING
Rochester, Minnesota
December 3, 4, 5, 6 and 7, 1923

Dental Radiology

BEGINNING with the January issue it is the purpose of the Journal to include publications of immediate and vital interest to those especially concerned with the dental aspect of the science of radiology.

Two series of articles are under preparation and the first numbers of these have been received at the editorial office. Coming as these series do from men of long experience and of unquestioned ability, and written in clean-cut, logical fashion upon subjects of practical interest, they will be of very great value to those especially interested in dental and oral pathology as well as to the general radiologist.

Dr. William Lete Shearer, M.D., D.D.S., F.A.C.S., and Dr. Albert D. Davis, M.D., D.D.S., of Omaha, are joint authors of a series of articles upon impacted and unerupted teeth, root-end pathology, and tumors of the jaws.

Dr. Shearer is a member of the American Association of Oral and Plastic Surgeons and is Oral Surgeon to the Swedish Hospital of Omaha. He is Visiting Surgeon to numerous Omaha hospitals, among which are the Methodist, the Clarkson, the Presbyterian, and Wise Memorial Hospitals. Also he is Instructor in Oral Surgery in the National Post-Graduate School of Orthodontia, Kansas City, Mo.

Dr. Davis is Oral Surgeon to the University of Nebraska Hospital, Omaha, and is also Instructor in Oral Surgery to the University of Nebraska College of Medicine.

The second series is by Dr. William A. Lurie, M.D., of New Orleans. Dr. Lurie has specialized for twelve years upon diseases of the mouth and particularly upon dental roentgenography. His series will deal with the technique and interpretation of shadows on the film, together with the clinical significance of these shadows.

Dr. Lurie has for years held classes in the interpretation of dental films and he has most generously offered to conduct a dental questionnaire in connection with his articles. Readers may ask any question upon Dr. Lurie's specialty and he will answer these questions in the columns of the Journal. Questions to be answered in the January issue of the Journal should be sent in at once to the Journal office, 121 South 33d Street, Omaha, Nebraska.

Chicago Physiotherapy Meeting

IT IS with a good deal of satisfaction that we can report the success of the Chicago Physiotherapy meeting, held at the Logan Square Masonic Auditorium, October 15th to 19th.

Four hundred and sixty-four physicians were registered from twenty-nine states, Canada, China and India. Not a single doctor who was scheduled to appear on the program missed his appointment, and all who attended were highly pleased with the program, as shown by the fact that none of them missed any of the lectures. Many men who had come into Chicago in advance of the meeting of the American College of Surgeons, came out the first morning and were so well pleased that they remained for every succeeding lecture.

It is a significant fact that, without a dissenting vote, the men there present passed a resolution to join the American College of Radiology and Physiotherapy. Such a response shows without doubt the wisdom of the formation of the College, indicating as it does the widespread desire of the men engaged in this work throughout the country for some such high class organization. In the past the members of the medical profession have looked with distrust upon the physician engaged in practicing physiotherapy because in America this method of treatment was so universally in the hands of charlatans, but the valuable help which it rendered medicine during the World War has done much to overcome this prejudice, and it seems that now is the opportune time for the medical profession to organize physiotherapy. Only in this manner can the value of this branch of therapy be saved to the medical profession and taken from the realms of the cult and the charlatan. It is much better to work from the inside out than in the opposite direction. The valued work of the American College of Surgeons stands as an ideal toward which the American College of Radiology and Physiotherapy strives in this branch of therapy. That is, cooperation of all men practicing x-ray diagnosis or treatment, radium treatment or physiotherapy treatment.

Let Electricity Figure It Out

DR. GEORGE W. CRILE, a Cleveland surgeon, thinks that man is simply a mechanism run by electricity and chemical reaction. He says electricity is the flame of life burning in some 28,000,000,000,000 cells of the body, each cell itself a tiny wet battery with negative and positive pole.

A few weeks ago, Dr. Francis A. Cave of Boston predicted there would come a time when human beings would absorb electrical vibrations instead of eating food. Recharging the body with energy will be done in the future by apparatus that will connect the body with a supply of electricity, he said.

We do not know whether to feel happy or sad about electricity. Perhaps the currents of electricity that make happiness and sadness did not get the proper stimuli from our meditation. If we could only feed our mechanism a charge of energy for a brain storm, the task of figuring out what man is, might be simple as a piece of mechanism

run by electricity. We find ourselves no closer to knowing what man is than Tennyson was to knowing what the flower in the crannied wall was. To tell us that man is an electrical machine is like explaining death by saying man dies like a dog. But who knows how a dog dies?

So we leave the doctors with their experiments to argue about it and about. And we wonder what the grocers, the butchers, the bakers, the farmers and all the folks who feed us will do if the time ever comes when we shall eat lightning. Gosh, what will the dentists do?"

The above editorial appeared in the Omaha World-Herald, October 24, 1923. What now about the need for education of the laity on medical and scientific subjects?

Service in Radiology

COMPARATIVELY speaking, I am young in the field of radiology; eight years measures the span. The allurement of a new and fascinating method of diagnosis drew me to the field. Diagnosis is the prop upon which therapeutics lean for support. Without diagnosis all therapy becomes empirical. My faith in the new method has been justified. Still I have never come to look upon the diagnostic value of x-ray as more than an important adjunct to the old reliable careful history and physical examination. The attempts of many radiologists to force the x-ray into the exalted position of a court of last resort has brought nothing but discredit and rebuke upon us.

I had not ventured far afield in this new realm of medicine until I became so fascinated with the work that all else seemed of small interest to me in comparison. With increasing interest was born a love for the work that brought with it all of the attributes of love, pride and joy in accomplishment, disappointment and sorrow in its failures and shortcomings, disgust and anger at its abuses.

Naturally, such an attitude looks solicitiously upon anything that influences, favorably or unfavorably, the development of the science. I am sure that most of my associates, and more particularly those who follow the practice of radiology exclusively, share my feelings in this matter. Exclusive practioners and even those who use it merely as a necessity forced upon them by modern medical armamentaria, must have an interest in this very important diagnostic and therapeutic method, and increased success in its mechanical, physical, technical, diagnostic and therapeutic phases brings elation to older workers.

Except for one reason no individual or group of individuals would hamper or obstruct, wittingly, these developments. This reason is personal greed, passion for personal aggrandisement. This is an unpleasant and unfortunate truth. Throughout the entire world of radiology, its progress, its usefulness, its value to both the medical and lay world's, is being obstructed by that great curse to human progress everywhere and in every realm of endeavor. Selfishness, avarice and greed, the monsters that sacrifice every virtue for their own worldly advancement are responsible for much that now exists in and must be eradicated from the world of radiology.

In the effort to win fame and fortune to themselves individuals, groups, cities, states and nations have followed ruthless methods until today this old world is in a state of chaos that beggars description and I am sure that selfishness, avarice and greed are playing the stellar roles in the etiology of our present world ills. There is a remedy for these ills, there must be, else civilization must totter and fall.

What is true of world politics is true of our profession of radiology. We must subscribe to and follow faithfully the principles of the golden rule and place service in the exhalted position to which it belongs if we are to achieve success. Adequate reward will follow as surely as day follows night or the seasons follow each other in perpetual rotation.

Time was when radiologists were few and equipment was inadequate and difficult to obtain. Much of it had to be acquired by personal construction. Then the pursuit of radiology was largely a matter of interest in a new and fascinating form of physical energy, then men studied to solve a new and difficult problem. It was during that period that the most stable and laudable achievements were made.

Not for long, however, did personal greed withhold its blighting influence from our loved profession, and from then until now radiology has fought this conscienceless mercenary demon. Unscrupulous avarice, greed, and self-seeking service has produced incompetent men, with no real pride or interest in the science of radiology as an ethical profession. These men, having not the slightest idea of how to interpret shadows in terms of pathology, have purchased equipment from short sighted salesmen, and let the full measing of those words be felt. The principal idea with such men is to possess a new office fixture as an added lure, which when kept well lubricated with buncomb will produce a mighty psychologic shock upon the receptive sensorium of a trusting and easily deluded clientele. It is so easy to prove a previously made diagnosis.

Also there has been produced the individual who, although he may or may not know his science well, has foolishly enough made exorbitant and unreasonable claims for x-ray as a diagnostic and therapeutic measure, thereby undermining the confidence that would otherwise be reposed in it, bringing the entire science into disrepute and subjecting it to ridicule.

X-ray diagnosis has made a mighty impression upon the minds of many diagnosticians, as well as upon laymen, even to the extent that they fear to express their own opinions in the presence of the radiologists. This feeling so common today is, I am sure, the result of exorbitant claims made for x-ray by the class of men just referred to. They have for a season succeeded in deluding the average referring physician, but the time is soon to come when these men will awaken to the fact that their most dependable props still are history and physical examination. Referring physicians will expect from the radiologist a report covering only those features of the case that are detectable in normal shadows or alterations therefrom. Furthermore, this report should be a statement of conditions found in terms that may be of use to the internist, or surgeon in many phases of his examination. To illustrate: When an internist examines a stomach he wishes information concerning all its phases—anatomic, physiologic and pathologic deviations. Before the days of x-ray he attempted to detect these things by other methods. We all remember how the stomach was inflated with gas to determine its size and location. This was before the day of x-ray. Now the diagnostic use of the ray furnishes this and other data on a dependable basis. Therefore, your report to him should come back covering those features that the x-ray demonstrates as no other method has done. It should, in the case of the stomach, which we are using for illustration, include details such as size, shape, position, mobility, tone, peristalsis, contour, location of tender points, emptying time, motility, etc. Append your opinion as to existing pathology gleaned from your x-ray examination, and this data, together with other laboratory findings and the information obtained by the internist will constitute the materials from which conclusions as to diagnosis will be drawn.

It is no disgrace and no belittling confession that x-ray is but an adjunct in diagnosis. Come, let us reason together.

radiologists, laboratory men, internists and surgeons, in order that we may render service.

I hope that standardization of x-ray reports may soon be an accomplished fact. I think I see possibilities for much benefit to the science of radiology, to mention but one item, I feel that it would do much toward eradicating the buncomb from x-ray diagnosis.

I hesitate to say that the characteristics mentioned above are responsible for the next type I will discuss. I really think this type is the unfortunate victim of circumstances over which he once had control but now has lost it. I refer to the under-prepared individual who is over-equipped. Commercialism has forced upon us (and here I refer to the mine-run of radiologists and not to the few who are prepared by careful training, long and large experience) "big Berthas" if I may be permitted to use this term, that are so potent for much harm as well as some good in therapeutics. Keenness of competition and the desire to impress the lay public with our stupendous equipment has placed in the field indiscriminately these machines which I feel sure, because of their indiscriminate use, are going to react most unfavorably upon radiotherapy.

Had they been held well in check and kept in proper hands until the development of mechanical, physical and technical details that would have made their use more nearly fool-proof, I can see how the eventual good that is to come from their use would have been ours without the great harm that now is in the harvest.

There are numerous manufacturers of these big guns and their product must be sold. Whether there are gunners trained to use this heavy ordnance is a matter of secondary importance to them. They are forced, through commercial necessity to market their product and the public, the trusting public, must pay the price; and here let me say that lay-publications, in their craving for the sensational, are largely responsible for injecting into the public mind exorbitant claims and false impressions of this startling piece of heavy artillery.

Also here let me plead with our leaders a point that I wish to make. There are in all specialties of medicine men who stand at the head, leaders, if you please, and to these we look for guidance. We listen to them, we read what they write, and they should, respecting the faith and trust we repose in them, be most careful in reporting upon their work. I have had reports from some of these that were misleading to this extent. They told of the good they had accomplished, the beautiful results they had obtained, but had a serious lapse of memory and forgot to mention their bad results and fatalities. When we who have sent these cases in for heavy treatment have had them returned to us in wooden shrouds or in such condition that they soon succumbed, death being due absolutely to over roentgenization, we have felt solicitious and sympathetic, but when later we hear these same men report on their work and forget to mention these fatalities we become distrustful and disgusted. We come to look upon them as placing their own personal interests above those of the profession in its ultimate development.

Not long since one of the leading internists of the Middle West said to me: 'I have my fingers crossed on the entire proposition of higher voltage x-ray treatment." This, gentlemen, is because of the bad results directly traceable to too much mechanical and too little mental equipment.

Next, it seems necessary to mention that low-bred but altogether too numerous type who seems to feel, that in order to increase one's business and magnify one's qualities one must tear down and discredit every opinion given or diagnosis made by a competitor in the tributary field. We see this spirit too frequently among practitioners in every field of medicine and surgery, and it is due to this that much of the lack of confidence in the profession as a whole results and it may be very largely responsible for the flourishing of sectarian practitioners.

What I am protesting against is the indiscriminate launching of floating bombs in an uncharted sea where no protection is offered to passing ships.

Just now there is being crowded upon our profession an over-supply of equipment for physiotherapy. It is being grabbed up by every cult practicing the healing art. This is being encouraged by venders of the working tools of our profession who make exorbitant claims as to the therapeutic value of these new office decorations which are really very usful therapeutic measures if properly used, but over enthusiasm breeds unjustifiable claims that will surely bring unfavorable reaction. Time will bear me out in this statement.

Let me quote from a letter mailed out by Drs. Mullins and Spencer:

> "In view of the wide interest in, and the great importance of the various phases of radiology and physiotherapy, and concomitantly, the imperative prerequisite of solid grounding in the science of medicine as a condition of intelligent practice of these branches of the medical profession, this meeting has been arranged—a meeting like which has been long in the minds of the officers of these organizations, but which until now has never been possible of accomplishment. We may say that the impetus given this co-operative idea by the action of the American Medical Association at its latest meeting in San Francisco has been of invaluable benefit to us in completing these arrangements, and will, we earnestly believe, prove a great forward step in *bringing us all nearer the standards to which we aspire*. To quote briefly from the minutes of the A. M. A., as reported in its journal, issue of July 14th, page 120: 'We feel, however, that the Association should recognize the increasing importance of special medical activities, such as radiology, physiotherapy and occupational therapy * * * and we recommend that the American Medical Association recognize the science of radiology as an integral part of medicine and surgery'."

The purpose of the meeting is clearly stated. We are asking for recognition. We are certainly worthy of it, and what I have written I hope you will interpret in the spirit of constructive criticism coming from one who takes the position that prophylactic measures, instituted to prevent the canker of those ills mentioned above from infesting our profession are timely. We can not totally eradicate these evils, but we can keep them at a minimum by each of us holding strictly to the practice of service before self.

W. A. RUSH, M.D., *Beatrice, Neb.*

Utah Society

A MEETING of the Utah Society of Radiology and Physiotherapy was held in Salt Lake City, September 18th, under the presidency of Dr. Mark Brown. The next meeting, to be held in six months, will take place in Ogden.

CASE REPORTS

Electro-Thermic Coagulation

A. F. TYLER, M. D.
Omaha

THIS PATIENT is a man who at the time I first saw him was 48 years of age. Following the Omaha tornado of 1913, in helping to clear away the wreckage, he bruised his hand near the cardinal's snuff box. Shortly thereafter he noticed a lump in that place and consulted an old-time friend of his—a surgeon. The surgeon made a diagnosis of sarcoma. He was referred to me for x-ray examination, which showed that the sarcoma sprang from the periosteum covering the trapezium. After we had discovered it arose from the bone, the surgeon wanted to amputate the forearm, but the patient refused. He was referred back to me for treatment.

We anesthetized the patient with ether, and used electrothermic coagulation, coagulating the tumor itself and destroying some of the tendons and the bone as well as the other tissues. This is an unusual condition and an unusual method of treatment, but the results which we obtained justified the adoption of this unusual method, because the patient is living and well nine and one-half years after the treatment was given.

This is the only case, so far as I know, in medical literature where periosteal sarcoma has been entirely eradicated without operation. I would like to have him show his hand to you. It is deformed, of course, because the tendons were destroyed. He has good use of two of the fingers and can use the others enough to enable him to carry on his occupation. Following the treatment with the electrothermic coagulation, he had x-ray treatment as well.

Photo nine and one-half years after treatment of sarcoma arising from trapezium showing scar and deformity resulting from electrothermic coagulation of soft tissues and bone.

Renal Tuberculosis With Calcification

C. H. DeWITT, M. D.
Valparaiso, Indiana

MRS. R. C. S., age 40, was referred to me for an x-ray examination of the spine, following an injury to the back.

The film revealed an interesting pathological condition of the right kidney, showing three calcified areas within the kidney shadow.

The patient had no urinary disturbance, and the urinary examination was negative.

She stated that about fifteen years ago she had kidney trouble for some time and that a diagnosis of renal tuberculosis had been made at that time.

Roentgen ray examination of the chest revealed evidence of healed pulmonary tuberculosis.

We concluded that it was a case of healed renal tuberculosis with calcification.

ABSTRACTS and REVIEWS

A Roentgenological Study of Tuberculosis of Lungs and Intrathoracic Glands in Infancy and Early Childhood. I. Edward Liss, M. D., New York Nursery and Child's Hospital and Cornell University Medical School. Am. J. M. Sc. 166:396-402, September, 1923.

ROUTINE roentgen ray examinations help the pediatrician to cut down the percentage of avoidable error in final diagnosis and are an invaluable help in prognosis. In the diagnosis of tuberculosis and respiratory infections of all kinds the x-ray is invaluable when clinical signs are confusing.

In the infant, reactions are much more intense than in the adult and changes are more massive. There is also a definite predilection of the lymphatic structures to disease. Chronicity is exceptional and the early stages of the disease are difficult of differentiation.

Generally speaking, the changes fall under two heads, glandular and those attacking the parenchyma. Glandular changes may be paratracheal, perihilus or peribronchial, the first named change coming earliest in child life, the last later. One region or several may be affected but eventually an entire chain is affected.

The early glandular changes show in the plate an evenly outlined shadow in the upper mediastinal region, rounded or elongated, dependent upon the degree of congestive reaction and the number of glands involved. Smooth contours and even densities are characteristic. Conflicting shadows may be neoplasms, congenital anomalies or the thymus.

The second stage in glandular tuberculosis shows changes due to necrosis and fibrosis. Outlines are irregular, blotchy, with so-called mottling, and there may be a zone of parenchymal congestion. If all this shows, a diagnosis of tuberculosis is a likely one. Retraction of the shadow may take place with an increase in density and accentuation in the mottling or a definite progression to parenchymal involvement may occur.

Parenchymal changes may be pleural or pulmonary. Pleural changes may be either (1) an intralobar effusion or (2) a complication of a diffuse pulmonary involvement. In the first type the process is sharply defined usually between the upper and middle lobes and usually subsides leaving a definite linear scar, but not all such scars are tuberculous. In the second type the changes may be serous or fibrous, serous in small quantities, fibrous in fine filament-like bands or, rarely, a diffuse plastic mass, not unlike adult pleuritis, shows. All combinations of types are present and the authors have never noted a primary uncomplicated tuberculous serous or fibrinous pleurisy.

Pulmonary changes are of three types (1) bronchitic, (2) bronchopneumonic, (3) and lobar. The first is but a stage in a general miliary infection, tubercle barely discernible, death intervenes before full growth of tubercle. Markings are accentuated and somewhat congested in appearance. This change is also seen with general miliary abscesses, due to terminal sepsis. If disease is prolonged the process merges into the secondary bronchopneumonic type which may be a bronchopneumonia from the beginning; if lobular in type the disease may be confined to one lobe or there may be extensive involvement with no area larger than one-half centimeter. In diffuse involvement the lung may be so riddled that only a few normal areas can be seen and every conceivable change may be manifested—minute effusions, fine fibrous bands, localized areas of thickened pleura, cavities, etc. The lobar or massive tuberculosis is the rarest type. Two instances of annular shadow have been found present in infancy. For exact visualization of the changes repeated roentgenographic investigation is very necessary.

Radiologic Gastro-Intestinal Studies in Epilepesy. Ward W. Harryman, M. D., and Samuel W. Donaldson, M. D., Uni. Michigan Med. School. Jour. A. M. A. 81:813-815, Sept. 8, 1923.

A review of the literature upon the subject would lead to belief that a colonic stasis exists in constipation associated with epilepsy. In the author's experience roentgen examinations proved that instead of a colonic stasis a hypermotility of the large bowel was present in more than 50 per cent of cases and that the others had normal motility. His conclusions read thus: "(1) No definite evidence of colonic stasis is found by roentgen-ray examination of the gastro-intestinal tract of epileptics. (2) The term 'constipation' is a complaint of the patient and associated with a cathartic habit. It does not indicate colonic stasis. (3) There are no indications for surgical procedure to relieve these patients of colonic stasis, since a true colonic stasis does not exist."

Roentgen Treatment of Primary Polyglobulia. Frode Rydgaard, M. D., Acta Radiologica, 2: No. 7, 242-260. June 1923.

THREE case reports are submitted. One was cured of polyglobulia by x-ray radiation of the spleen and the others by x-ray radiation of spleen and bone marrow. The former method alone usually produces no effect upon the disease but vigorous x-ray radiation of the bones seems to be an effective remedy. Only the long tubular bones should be irradiated as it is here that hyperplasia is found, and they are usually also the seat of a great deal of pain with this disease and irradiation affords relief. If the spleen is enlarged it is irradiated but otherwise it is not.

The aggregate dosage must be fairly large. Caution is called for in the single series treatment else a sharp decrease in erythrocytes may bring about extreme exhaustion—and it must be remembered that the fall in the number of red corpuscles may not occur until some weeks after treatment.

Series treatments of 10 single doses of 2 to 3 "Sabouraud" are given on one area and after each series the patient must be observed for a month when, if the red count does not fall below five million, a new series is given. As soon as it does fall below five million treatment is postponed for a time. Two to four series are usually sufficient. The dosing of the spleen is a disputed question. The author states that "it perhaps is permitted to conclude that the dosage for the spleen should be between 8 and 16 Sabouraud."

Dermatitis Artifacta Simulating Roentgen Dermatitis. George M. Mackee, M. D., and George C. Andrewes, M. D., College of Physicians and Surgeons, New York City, Am. J. Roentgenol. 10:617-622, September, 1923.

THE introductory paragraph is an abstract of the article. It reads thus: "In this article attention is called to the fact that self-inflicted injuries, lesions and eruptions, that

may be classified under the general heading of dermatitis artifacta (malingering, dermatitis factitia, feigned eruptions, neurotic excoriations etc.) may spontaneously or accidentally simulate roentgen or radium dermatitis; also that malingerers may intentionally and more or less successfully imitate a roentgen or radium dermatitis. In the latter instance the object is revenge, to avoid work, to collect insurance, to excite sympathy, interest, fear, etc. The fact that self-inflicted eruptions may simulate roentgen or radium dermatitis to a degree that will deceive the inexperienced or the unwary, is of scientific interest and of medicolegal importance."

Several case reports are submitted.

What Causes the Healing Action of Roentgen Rays? Summary of a paper by G. Holzknecht, M. D. Read in April, 1923 before the German Roentgen Society. Arch. Radiol. & Electroth. 28:85-89, August, 1923.

FREUND of Vienna believed that roentgen effects were caused by electrical discharges outside the tube. Had this been true radiotherapy would have ceased to exist. "If the assumption is wrong, that ray treatment frequently causes functional increase, then we are in a *cul de sac* * * * it occurred quite recently in the case of the unit dose for carcinoma and sarcoma."

The physicist has devoted endless energy to measurement of dosage and to the effort to secure equal distribution of dosage and of this Dr. Holzknecht says, "The tenacity with which these investigations have continued must be admired, but at times one feels that it is an overestimated idea." In medicine, he reminds us, it is customary to use a quantity of medication suitable to the individual case under treatment, the best dose being the one having the least damaging effect and the greatest modifying result—but not so with x-rays. He questions the correctness of this and asks if there is such a thing as a stimulative dose.

He attacks the Arndt-Schulz laws, "dating as they do from pre-chemistry days", and says that the dicta thus laid down (small quantities of every agent stimulate, medium quantities retard, large quantities destroy) are not accepted by pharmacologists nor by biologists—for example, the action of curare and cocaine cannot be reconciled to this law. "Many agents are harmful in any quantity. As to what category x-rays should be placed in is a question as yet unsolved and only approachable on the grounds of probability.

"The records of radiology for the first fifteen years mention only the retarding and damaging effects of x-rays, and these were the years when only small intensities were employed. The doctrine of stimulation only came into existence with the era of large doses. If there really exists a stimulative dose for carcinoma, then right up to 1915 we have been stimulating malignant growths; an obvious contradiction. Even today there are no cases reported which are not open to doubt, and those who describe them do not venture beyond opinions, because in their statistic tables the column for 'stimulated' and 'aggravated' is absent.

In Explanation of the Action of X-Rays Is It Necessary to Assume Functional and Growth Stimulation? Summary of a paper by Fritz Pordes, M. D., read before the German Roentgen Society, April, 1923. Arch. Radiol. & Electroth. 89-93, August, 1923.

DR. Pordes says that the Arndt-Schulze law may hold for x-rays but he doubts it for the reason that "It is well known that the cells of the human organism are dependent on the action of several agents to which the cells are accustomed, and their effect produces stimulation, as for instance light, heat, oxygen, carbonic acid, potassium, calcium, etc.; these act on the whole nature of the organ, and among them must be sought those which act directly on the cells and seem natural to them, and under certain circumstances act as stimulants, but even these when applied indiscriminately can become harmful and even lethal, not only to the cells but to the organism. Therefore, agents which are not natural to the cells, or inadequate agents, cannot with prabability be regarded as stimulants." X-rays are in a higher measure unnatural to the cells, and they exert an effect to which these cannot be physiologically accustomed.

Furthermore: "If we irradiate eggs the incubation period is shortened and the chickens are hatched soon, but there occurs something noteworthy. Highly bred chickens, such as game fowls, lose the particularities of their strain and cast back to the commonest of types. Should these fowls be considered as physiologically improved?" Weber irradiated lilac buds which came quickly to maturity but developed an early necrosis and perished. Teaching data are too often gathered from doubtful results. Information must be obtained from fully developed organisms.

The assumption of stimulation will not do as a working hypothesis. He says: " * * * in order to explain this x-ray effect, without the stimulation hypothesis, the following point must be elucidated: What is the type of cell comprised in a radiated area which possesses the highest sensitiveness to radiation and which in consequence would be the most prone to injury? Then it is necessary to ascertain the diminution or elimination of that particular type of cell, and whether its disappearance always produces the same effect. If we can do so, then x-rays may be regarded as a uniform mechanism, our difficulties become lightened and chaos ended. * * * Let us for a moment enquire which type of cell in an inflammatory field exhibits the greatest degree of sensitiveness. We know now that it is undoubtedly the white blood corpuscles, that the leukocyte infiltration produces the highest degree of sensitiveness, and consequently is the first to be destroyed. It may be urged that the x-ray effect will only harm and not heal, because the leukocytes and phagocytes rally to the defense of the organism in a remarkable manner." Here, Lubasch is quoted to the effect that reparative infiltrations are often produced in such an abundance that they act oppressively on the cells of the organism. Furthermore the writer says:

"Is it not natural and probable that a series of certain x-ray effects, unsatisfactorily explained hitherto, may be attributed to a reduction of the pressure brought about by a decrease of the leukocytes due to x-rays, such as, for instance in phlegmon, erysipelas, parametritis, glandular tumor, chilblains, etc.? The removal of nephritic anuria * * * is also capable of the same explanation. The leukocytic infiltration of acute nephritis increases the pressure inside the kidney capsule, which pressure disappears with x-ray treatment and the function of the organ is restored, apparently just as well as with surgical decapsuling of the kidney. Hence the theory of the resumption of function on the part of the epithelium of the kidney is extremely improbable. * * * The reduction in the number of leukocytes in tuberculosis permits the free infiltration of the auto-tuberculin, producing, as Iselin states, an active auto-immunization, and in this manner many effects resulting from x-ray therapy of pulmonary tuberculosis may be explained." Further on he suggests that "the accelerated passage of blood in a radiated spleen is a much simpler explanation than that of stimulation of the function of the spleen" for the effects produced and amenor-

rhea resulting from small x-ray doses are probably due to the reduction of pressure and not to stimulation though it might be due to an outflowing of hormones, through the destruction of the more mature follicles.

If cells of mature organisms are examined after radiation, not rapidly growing organisms such as eggs and buds, it will be found that the common belief that the nucleus is the most sensitive to radiation will be disproved.

In the concluding paragraph he says: " * * * all the x-ray effects are comprehensive if we keep in mind the different degrees of sensitiveness of the cells lying in the radiated zone; and if we investigate the result arising from the elimination of these particular cells and note the biological effects on the organ, we shall arrive at the conclusion that all x-ray reaction may be regarded as one uniform mechanism, which consistently delays real growth, and is quite irreconcilable with the hypothesis of stimulation."

Results of Skin Tests Made to Determine an Objective Dose for Radium Radiations. Archie L. Dean, Jr., M. D., Memorial Hospital, New York City. Am. J. Roentgenol. 10:654-661, September, 1923.

AN empirical method was employed using the skin as a biological indicator with radiation sufficient to cause a faint erythema. The method eliminated the usual subjective errors, thereby the effect of filtration on radium radiation was determined. Quoting from the conclusions to the paper the authors say: "The results show in what proportion the millicurie-hour doses must be varied to produce the standard erythema with brass filters varying from zero to two millimeters. The millicurie-hour doses of Table I are for a distance of two centimeters. For any other distance they will be different but they will maintain the same relative values. Having used skin erythema as a biological indicator, the results are directly applicable to skin dosage in radium therapy. The determinations were made empirically, since no other method is available at the present time. The results, therefore, are not dependent upon any assumed correspondence between physical measurements and biological effects "In attempting to formulate a skin test the result of which would enable us to treat the patients more accurately, we found that the secondary reaction to gamma radiation, when the erythema dose was applied, was closely associated with the subsequent therapeutic result. This finding was borne out in over 200 cases and for many variations of tumor.

"Among those patients who reacted with a skin erythema to the test application of radium and received radium therapy, examination of the records at least six months afterwards showed six benefited to one unimproved. Likewise, considering the class of negative skin tests, or those patients who failed to respond to the test application by the formation of a visible gamma secondary reaction, the number of those not benefited by radium therapy was greater than those who were improved in the proportion of eleven to one.

"It was found that the reactions to the radium skin tests were intimately associated with the quality of the blood of the patients tested. Those with normal or nearly normal blood reacted readily to the skin erythema dosage, while anemic individuals either failed to respond entirely, or reacted faintly and atypically. The association between the positive skin test and favorable blood findings has been so close throughout these experiments that we believe the latter factor to be of the greatest prognostic value. On the basis of our results the patients with a normal or nearly normal blood picture, other factors being equal, will be benefited or cured by radium therapy, while the anemic individuals will fail to show such a favorable response to the same treatment. We therefore recommend the routine blood examination of each cancer patient, both before radium treatment and during the course of observation, with the idea of maintaining a high hemoglobin content and red blood cell count, so that the most favorable reactions possible may result from our radiation therapy."

The X-Ray Department. John B. Zingrone, Director X-Ray Laboratory, Mercy Hospital, Chicago. Hospital Progress, 4:341-344, September, 1923.

A thorough and reliable x-ray technician should have a knowledge of elementary electricity, knowledge of how to operate the machines and to prevent injury to self and patient and damage to apparatus, knowledge of photography and chemistry sufficient for perfect results in dark room work. The technician should know the osteology and anatomy of all organs demonstrable by the x-ray. At least high school education is preferable.

Plans for the laboratory should not be left to the architect or building committee. The roentgenologist has a knowledge of his needs that they do not have. No one plan will be satisfactory under all conditions but the size of the hospital, nature of the work to be done and funds available must all be considered in the plan. The writer does not agree that the x-ray room should be next the operating room. Arrival and departure of patients and noise of apparatus in a busy x-ray department is not a desirable environment for the operating force next door, to say nothing of the dust carried by the air currents through communicating passages. "If the routine is established that all radiograms be examined by the surgeons in consultation with the roentgenologist very few of the radiograms will be required in the operating room." The x-ray department in the Mercy Hospital of Chicago is located on the ground floor close to the emergency entrance and within fifty feet of both freight and passenger elevators.

A model x-ray department consists of a reception room, large and well ventilated, executive offices for stenographer and file clerk, diagnostic room for interpretation of radiograms with complete illuminating and stereoscopic apparatus, fluoroscopic room with vertical and horizontal outfits and x-ray machine for general radiography together with a lavatory. It should have a general radiographic room equipped with latest type x-ray machine, radiographic table, Bucky diaphragm attachment and three Coolidge tubes (fine, medium, broad focus), lead lined boxes for films, a stereoscopic outfit for either vertical or horizontal steroeradiography, lead numerals and letters for marking films. It should have a therapeutic room with a high tension transformer, four x-ray tubes of latest model, wooden table, tube stand, lead glass casing around tube, and leaded rubber sheeting for patient's protection. Walls, ceilings, and floors of every room should be lead lined for at least one-eighth inch, and the treatment room must be so lined.

The department should have a machine room to contain the machines for both rooms—this avoids noise and protects the operator, at least a booth for the operator with a leaded glass window should be provided if the machine room is absolutely out of the question.

The dark room should have a ventilating system and all the necessary apparatus for the work to be done there. A storeroom for the chemicals, films, and portable machine should be provided, at a distance of 75 to 100 feet from the field of operation to avoid fogging of films, etc. Dressing rooms and lavatories enough for the patients, and a preparation room for preparing emulsions, storing linens etc. are necessary.

Patients are apt to be nervous upon a first visit and they should be told that the procedure is painless and is very necessary for diagnosis. The machines should be tested before the patient enters the room and the technician should be kindly and considerate in moving the patient to proper position, etc. No dressings or casts should be removed by the technician without first an order from the attending physician and no radiograms shown to another physician or a patient without the order of the attending physician. In the author's laboratory operating gowns with ties, no buttons, are used for men patients and plain nightgowns for women. Patients appreciate this protection.

The technician is not an interpreter. The author after 14 years feels that he has much to learn about interpretation.

Working hours for the personnel should not be more than seven daily, with Sunday and another half-day holiday which should be spent outdoors as much as possible. Two weeks' vacation is the minimum. In hospitals those working in the x-ray department as technicians or nurses should have no additional hospital duties. Ventilation should be by suction outfit and electric fans besides an air-cooling system.

Tubes for screen examinations should be inclosed in protective material equivalent to 2 mm. lead and the fluorescent screen should be fitted with lead glass.

The author conducts his laboratory at a ten per cent profit above all expenses. A complete price list is given in the original paper. During 1922 his department made 3,201 examinations.

The Role of Deep X-Ray Therapy in the Fight Against Cancer. Nathan B. Newcomer, B. S., M. D., Denver. Read at the Annual Meeting of the Wyoming State Medical and Dental Societies, Laramie, June 20, 1923.

CANCER treatment, says the writer, has remained the same from centuries before the Christian era up to the discovery of x-rays and radium.

The American Society for the Control of Cancer estimates the number of cancer patients in the United States at any one time to be 300,000. Statistics are quoted from many prominent cancer workers and the author's conclusion is that, while x-rays and radium are curing from 15 to 30 per cent of inoperable cases, the surgeons are largely blind to the facts.

The author's technique is described in the paper and a very interesting part of this section deals with the differences in technique necessitated by high altitudes. He says: "We measure the voltage that a machine will produce by the distance a spark will jump at sea level under standard conditions of atmospheric pressure, temperature and humidity. At the altitude of Denver there is often a difference of 46 per cent in the distance a spark will jump between points. The manufacturers make most of their machines at sea level and do not realize how much they must separate the different parts of the machine to prevent sparking between parts, and they seem to think that you do not know what you are talking about when you tell them of your difficulty. I have seen 60,000 volts as measured on the primary voltmeter jump nine and one-half inches between parts of the machine and between points of wire. We have tested two 85,000 volt machines which should deliver seven and one-half inch gap, and they would spark between parts of the machine at four and three-fourths inches at the altitude of Denver. So the maximum output of these machines would be less than 60,000 volts at the altitude of Denver." The fact that a man has all the equipment possible does not argue that he knows how to use it and harm is being done by those who do not understand the principles of treatment.

The author's conclusions are: "First, * * * surgery and radium can cure a small percentage of cancer only, and then only when the condition is limited to the primary focus, and their pitiful percentage of cures shows in what a small percentage of cases it is so limited.

"Secondly let us remember that no case of cancer has been properly treated without thorough irradiation by modern deep therapy methods, with a machine capable of delivering at least 200,000 volts to the tube terminals with heavy filtration and administered by a man trained in the physics of deep therapy.

"Finally, let us remember that many cases of inoperable cancer, apparently hopeless (if not actually cachetic), attain a clinical cure by proper deep therapy treatment as administered above."

Observations on X-Ray Cancer. J. Henry Dible, M. B., M. R. C. P. and J. M. Woodburn Morison, M. B., C. M., University of Manchester. Arch. Radiol. & Electroth. 28:65-72, August, 1923.

IT has often been held that the essential in producing experimental cancer is the presence of a specific substance stimulating the growth of epithelial tissues; but x-ray cancer stands alone in that it is caused by a purely physical agency, for if growth promoting substances are present they certainly are not connected with the prime irritant.

A case of x-ray cancer is reported in a radiologist in the Oldham Infirmary. He has been exposed to the rays for twenty years and at first did not use protective devices. About 1911 he began to notice a burning irritated sensation in his hands, particularly at night, but there was no real pain. Soon after this the skin and tissues of his hands became noticeably shriveled and discharging warts appeared upon the backs of his hands. The ulcerated areas extended and refused to heal in spite of numerous forms of treatment and one of them was of such nature as to be suspected of malignancy. Amputation of the first, second and third fingers of the right hand was done, and histological examination of this particular growth proved it to be a typical squamous-cell carcinoma differing in no essential from tumors of this type occurring in the skin. Sections of isolated warts showed only simple keratoses.

About twenty months later examination showed no recurrence, healing of the surface was complete, a few warts present on the remaining fingers of the right hand. The left hand showed a few small, hard, scattered warts with no ulceration. These were gradually growing smaller.

A review of the literature shows that in one class of x-ray carcinoma the disease spreads rapidly when once under way—in the other type lesions are very callous and remain local.

Recent Developments in Protective Methods and Appliances as Used in Radium Therapy. Curtis F. Burnam, M.D. and Grant E. Ward, M. D., Baltimore. Am. J. Roentgenol. 10:625-632, September, 1922.

THIS artical is supplementary to the one by Dr. Howard A. Kelly on "The Care of Radium in the Hospital" which appeared in the May 1922 issue of the *Modern Hospital* and was abstracted in the July 1922 *Journal of Radiology*, page 300.

The essentials necessary for protection are claimed to be met in certain apparatus described in this paper (tables, cylinders, emanation carriers and suspension apparatus). The illustrations and detailed descriptions of these must be seen in the original paper to be of value.

The essentials of efficient apparatus are given as: 1. Prevention of radiation of patient except at site of disease. 2. Cross-firing without overlapping. 3. Absolute immobility. 4. Easy and accurate manipulation. 5.

Comfort. 6. Protection of nurse.

The authors favor the use of aluminum and rubber filters to absorb soft secondary radiation when using lead protection (in treating cavities the gauze used in wrapping the lead filters absorbs the soft secondary rays from the lead).

The treatment tables described facilitate heavy external treatments and all treatments which require a change of posiion from the perineal to the dorsal, and at the same time an added protection is given those who are in the rooms below the treatment room.

The Removal of Tonsils. With Special Reference to Methods Other Than Complete Enucleation. Burt Russell Shurly, M. D., Jour. A.M. A. 81:800-802, Sept. 8, 1923.

THE author does not regard with favor the use of the x-ray in diseased tonsils, his experience being very unsatisfactory. He does recommend that it be tried in bad operative risks, that is, in the "bleeders", in advanced pulmonary tuberculosis, cardiac disease, nephritis, diabetes, borderline cases and for the neurotic, the senile, the fearful and the hysterical patient.

The Resistance of the Thyroid Gland to the Action of Radium Rays. The Results of Experimental Implantation of Radium Needles in the Thyroid of Dogs. J. O. Bower, M.D., F.A.C.S., and J. H. Clark, M.D., Department Surgical Research, Uni. Pennsylvania. Am. J. Roentgenol. 10:632-643, September, 1923.

THE experimental work here reported was undertaken to determine the effect of radium rays on normal thyroid tissue. The results seem to indicate that the type of tissue irradiated is of equal importance with dosage used. Conclusions from the study are:

1. "The primary changes induced by radium in the thyroid are hemorrhage and necrosis. Organization and healing are evident the third week and complete about the twelfth.

2. "The normal thyroid gland is distinctly resistant to the action of radium; it is not a good tissue for the study of the finer histologic changes produced by radium; the nuclear degenerative changes characteristic of radiated malignant tissue were never seen.

3. "No toxic symptoms of any sort were observed.

4. "No changes were demonstrable in the parathyroids.

5. "The apparent resistance of the thyroid tissue to radiation would make it appear that implantation would be superior to surface applications, and that relatively large dosage must be employed to assume any extensive effect upon the gland."

Elevation of the Diaphragm. Unilateral Phrenic Paralysis. A Radiological Study with Special Reference to the Differential Diagnosis. J. M. Woodburn Morison, M.B., C.M., Royal Infirmary, Manchester. Arch. Radiol. & Electroth. 72: 353-364, May, 1923 and 28:72-83, August, 1923.

EVENTRATION of the diaphragm and unilateral paralysis are indistinguishable both clinically and radiologically except that a definite pathological lesion involving the phrenic nerve in its course through the thorax can be demonstrated in cases of unilateral phrenic paralysis.

The term "eventratic diaphragmatica" should be applied to "those cases of congenital origin in which there is a diffuse relaxation of one-half of the diaphragm, so that it extends high up into the thorax, forming a sac which contains a portion of the stomach and sometimes a part of the colon and mesentery. All the cases recorded have been on the left side with the exception of one by Eppinger in 1911."

The radiological examination makes it possible to interpret the signs found upon physical examination and to render a correct diagnosis. The diaphragm extends high up into the chest, forms a dome inclosing an air space upon the bottom of which lies a free fluid which upon palpation shows waves and ripples. The presence of this horizontal line of fluid depends upon the amount of fluid in the stomach, but the level of the line is always that of the cardiac orifice. The upper boundary of the dome appears as a bow line, unbroken across the left hemithorax and maintained in all positions. It is formed by the thinned out diaphragm. The author differs with those who say that no movements of the bow line occur. They may be very slight. They move upward with inspiration and downward with expiration, if there are no adhesions to the lung.

The air sac of the dome is always present, at times a portion of the colon may be found lying alongside and the different pressure of gas in the colon and the stomach may cause an irregularity of the bow line. Lung tissue can usually be seen through the air space of the dome, but whether it is seen probably depends upon the development of the left lung. There is a real difference in the expansion of the right and left chest. Part of the heart shadow is also usually seen but displacement to the right is not a marked feature and when it apparently exists may be due to rotation. In nearly all cases there is a definite deformity of the stomach, due to the ascent of the greater curvature under the elevated diaphragm, with rotation on more or less fixed points which may be great enough to cause a volvulus requiring surgical interference.

Unilateral phrenic paralysis is not uncommon and it may be diagnosed definitely by the x-ray. The author has had nine cases within the year, two proved at postmortem. The right phrenic nerve was involved in two, the left in seven. Three cases occurred in secondary carcinoma of the mediastinum, secondary in one case to that of the stomach, in the other two to that of the breast. Three others were associated with pulmonary tuberculosis, two with a growth in the chest and one with aneurysm of the aorta.

Disease or injury may affect either the right or left phrenic nerve and cause paralysis of the corresponding leaflet of the diaphragm. In left phrenic paralysis the radiological signs are the same as for eventration. "It is only a question of variation in degree and of complications due to the presence of active disease." (Series to be continued in future numbers of Archives of Radiology and Electrotherapy.)

Complete Anterior Dislocation of the Distal Epiphysis of the Femur. Theodore West, M.D., Am. J. Roentgenol. 10:519-521, July 1923.

WITHOUT an x-ray examination this injury may be mistaken for a simple fracture of the lower end of the femur. It is important that the true condition be known else compression of the popliteal vessels may result in gangrene. Also it is important with these lesions that prognosis be guarded since any injury to an epiphyseal line may destroy the center of growth and the bone will then become shorter than its mate.

The lesion may occur at any time before the age of 23 or 24, the age at which ossification of the femur is complete. The greater number of cases occur between the ages of 10 and 20 years, the most active years, and may be the result of a fall or of traction in setting or treating a hip. Any disease which affects the growth or development of the bones is of course a predisposing factor.

A typical case is reported.

Observations on Ostitis Deformans. Sherman Moore, M.D., Am. J Roentgenol. 10: 507-518, July 1923.

THE literature is reviewed and four unusual cases occurring in the author's practice are reported.

The literature records 246 cases, exclusive of 14 in the author's practice. The facts scarcely warrant the commonly accepted belief that the disease is very rare. "The probabilities are that if sufficient x-ray search were made, the disease would be more frequently discovered."

When a case is fully developed, diagnosis can be made at a glance but senile and arthritic changes of the skeleton closely resemble the deformity of ostitis deformans. Limited to a single bone it much resembles syphilis but syphilitic tests plus antiluetic treatment will differentiate the condition. Differentiation must be made between syphilis, tumor, chronic inflammatory states, true hypertrophic changes, ostitis fibrosa cystica, osteomalacia and (restricted to the skull) hyperostosis cranii and leontiasis ossium.

Radiographic findings in order of their importance are: changes in texture, size, form and outline of bone. Deformity is largely the result of bony creased bulk arising neither from an internal expanding process nor as an enlargement. Most significant is in- apposition or accretion. In the cortex of the long bone there is early a rarefied condition. Instead of a homogeneous smooth-textured, compact layer there is a wide-meshed, coarsely reticulated structure in whose interstices is a softer tissue relatively deficient in calcium. Later on there appear irregular, patchy, dense bone condensations. Rarefaction and condensation go on side by side, the former is primary, the latter is reparative. Alterations of form are a late manifestation and a distinctive finding. Pagetic bone is smooth in outline and its curvature is even. However, radiographic findings in this disease are very difficult of verbal description and the findings vary with the state of development.

"From the standpoint of treatment it is useless to study Paget's disease at present. It should, however, be carefully investigated, for the reason that there might be uncovered a function of bone other than the rather passive ones of support and the housing of blood-forming organs. It is conceivable that aberrance of this possible function may produce the disease known as ostitis deformans."

Roentgen Ray Study of Non-Luetic Periosteal Bone Lesions. Roy G. Giles, M.D., Am. J. Roentgenol. 10:593-599, August, 1923.

THE periosteum casts a shadow only when calcium salts have been deposited in it. Periosteal bone production is the result of a reaction to some irritant acting as a stimulus.

Non-luetic periostitis and the new subperiosteal bone may be seen in fractures or in trauma without fracture, osteomyelitis, tuberculosis, typhoid, leprosy, pulmonary osteoarthropathy, ostitis deformans, rickets, scurvy and in proliferative bone tumors.

The points in diagnosis are discussed for each of these, in too great detail to abstract.

The Correlation of the Radiographic Bone Pathology of the Jaws with the Incidence of Secondary Infections. John S. R. Heath, L.D.S., R.C.S., (England). Dental Cosmos, 65:937-940, September, 1923.

FOR an oral radiogram to be of full value the case history and all other potential forms of infection must be fully considered. Diagnosis is too often limited to a study of the state of the periapical tissues and the amount of destruction of interdental bony septa, with no attention to the effects of infection upon the fine osseous network of the alveolar processes and adjacent jaw bone. The pathological changes in these structures are of course dependent upon the virulence of the invading organism and the resistance of the individual. Moreover it takes a trained interpreter with a good knowledge of pathology to interpret the changes wrought by chronic infection. The true state of the finer structures calls for study by transmitted light in a dark room, aided by the magnifying glass. Most dental radiograms are overexposed, or taken with too hard a tube, and are of value only for the study of gross changes.

This article is written only for those who "know the microscopical and macroscopical morbid anatomy of bone" as a reaction to a chronic infection, and it is inferred that no others should consider themselves competent to pass upon dental radiograms. The reaction from an oral infection is not so different than the reaction from the same infection would be in any other part of the system. "As * * * x-rays show us only relative translucencies we must interpret from these the effects of * infections on the jaw bones, and learn by testing clinically the result of removing these infections to correlate our pathology of the jaws with the etiology of secondary infections."

Dr. Stanley Colyer of London is thus quoted as to the three chief types of pathology which may be found by detailed study of the film with a magnifying glass:

(a) Wooliness or fleeciness of bone, due to thickening of trabeculae and decreased translucency of cancellous spaces.

(b) Patches of either increased or decreased translucency. First type is irregular, due to rarefaction but may have sclerosed area surrounding. Second type (decreased) due to sclerosis, may be sclerosed trabeculae or "healed small dark spots."

(c) Small dark spots surrounded by sclerosed bone are strong evidence of an active or residual infection liquefying the cancellous areas—density of surrounding sclerosed ring indicates resistance offered the bacteria. The evidence of their infectivity is (1) clusters of these around infected teeth (2) occurring in interdental bony septa when there is a marginal ostitis (3) and appearing close up against exostosed roots.

These must not be confused with canals of nutrient vessels which have a similar appearance. Colyer believes that treatment will probably be successful when the sclerosis in large or small masses exists without the presence of rarefied areas or clusters of small dark spots. The author of this paper however does not believe that Colyer has made this clear and in further elucidation he himself says:

"The 'small dark spots' would indicate, I think, colonies of bacteria of such a virulence as could live in the cancellous spaces at some little distance from the area of primary infection in spite of nature's attempts to remove them, showing the possibility, at least, of their being able to settle down and live still farther afield. In the cases I have dealt with showing 'small dark spots' there has consistently followed a fairly acute systemic reaction with an increase of the secondary symptoms. This has occurred so consistently as to establish to me these 'small dark spots' as of first-class diagnostic importance. When the spots have around them white circles of sclerosis, or attempts at sclerosis show elsewhere in the radiogram, I have found that the alleviation of the symptoms has been in fairly direct proportion to the density of the sclerosed areas."

Dr. Colyer's findings, Dr. Heath believes are based on sound evidence.

The Roentgenographic Study of the Mucosa in Normal and Pathological States. Richard A. Rendich, M.D., Bellevue Hospital. Am. J. Roentgenol. 10: 526-637, July 1923.

THE condition of the gastric mucosa has been studied chiefly through consideration of the rugae. The principal object of the study was to demonstrate the rugae as indicative of

gastritis.

The author has found that pathological changes of the hollow viscera are roentgenologically revealed before any deformity of visceral outline is produced. The condition of the mucosa is a very important pathological feature and radiographic demonstration of its abnormalities appears so characteristic that it can be made very useful in diagnosis.

A fifty per cent mucilage of acacia with an equal volume of bismuth subcarbonate is used with the patient partially recumbent on the fluoroscopic table. The patient is not allowed to raise himself and palpation is not desirable. Exposures are made directly after placing the screened film in position.

The method has served the author satisfactorily in: (1) more detailed and confirmative examination of gastric ulcer; (2) more complete study of gastric neoplasm; (3) differentiation of extra gastric pressure defect from intrinsic gastric lesions; (4) more satisfactory examination of the enterostomized stomach; (5) the study of gastritis; (6) the demonstration of the small intestine; (7) detection of mucous erosion; (8) further differentiation of benign and malignant ulceration; (9) differentiation of spasm from organic lesion and differentiation of duodenal and periduodenal adhesions.

Secondary Signs of Gall-Bladder Pathology. Ralph D. Leonard, M.D., Am. J. Roentgenol. 10: 521-526, July 1923.

DR. LEONARD states that he has felt somewhat disturbed over the fact that certain leaders in the medical world have expressed grave doubts of the value of x-ray diagnosis of gall-bladder pathology. He put some searching questions to himself and came to the conclusion that the difference of opinion was more apparent than real. At times roentgenologists have based their conclusions on weak premises and have been overenthusiastic in their claims, at times technique and interpretation have been at fault, but between the two extremes of the skeptical and the over optimistic is "a safe and sane ground where honest and careful roentgenologists may successfully employ the x-ray in the study of gall-bladder disease, both with satisfaction to their consultants and profit to their patients."

First of all, gall-bladder statistics are, necessarily, usually derived from incomplete premises; statistics thus derived are of course useless or even vicious. Operative cases form a very small per cent of all those coming for diagnosis, and gall-bladder diagnoses can be checked up only at operation. If operation is necessary the case is so advanced that there scarcely can be error in diagnosis of gall-bladder pathology. The careful and persistent pathologist can find at least a slight pathology in every adult gall-bladder over the age of 23. (In the discussion of this paper Dr. Cole stated that if the pathologist's salary depended upon the hospital he most certainly would find this pathology in every gall-bladder surgically removed and sent to him.)

A "negative" opinion arrived at in a routine examination, or in examination for ulcer or appendicitis, is often confirmed but practically speaking it is misleading if regarded as giving a true evaluation of x-ray diagnosis.

Again, the roengenologist can very easily be influenced by his knowledge as a clinician. In this way the x-ray is often given credit which does not belong to it.

Lack of success in diagnosis often rests upon the worker's lack of appreciation of the relative value of the different classes of x-ray evidence of gall-bladder disease. Two-thirds of correst diagnoses are based upon indirect evidence, i. e., demonstration of changes produced in other organs by gall-bladder disease. Less than a third of cases will show definite direct evidence such as gall stones or a visible gall-bladder.

One class of indirect evidence is found in pressure deformities, the duodenum being most frequently affected. The typical curve of the gall-bladder may be seen on the exterior surface or perhaps on the superior surface. Pressure from above will produce a flattening of the cap almost pathognomonic of gall-bladder disease. (Dr. Cole in his discussion remarked that other things in the right hypochondrium might give the same effect and must be kept in mind, e. g., the caudate lobe). The antrum of the stomach, particularly with enlarged gall-bladders, may show characteristic pressure. With considerably enlarged bladders pressure effects may be noted in the hepatic flexure or proximal transverse colon.

Adhesions may account for changes. The stomach and first portion of the duodenum may be abnormally fixed over the right side. The second portion of the duodenum may be displaced in widely varying degrees to the right. Occasionally the hepatic flexure and proximal transverse colon show evidence of fixation due to gall-bladder pathology, the latter may be angulated and displaced upward (pseudo-hepatic flexure). It may also have a tab-like projection pointing upward and inward from its superior surface; this is definitely characteristic of gall-bladder adhesions.

A rather extensive tonic contraction of the pyloric half or third of the stomach persisting throughout several films or in the fluoroscope is a very suspicious sign and the same is true of the ampulla of Vater rendered visible by barium retention.

Very often the indirect evidence consists of such a slight variation from the normal that any but the experienced worker will fail to detect it.

Direct evidence is found only in the minority of cases. Mistakes may occur here from the shadow cast by a food filled antrum of the stomach, which, however, will be an inconstant shadow. An unusually shaped edge of the liver, or a kidney, may cast a confusing shadow. Congenital diverticula may be mistaken for the ampulla of Vater which is not so large but about the size of a pea and is confined to the inner side close to the second portion of the duodenum at about the juncture of the upper and middle thirds. Diverticula may be found anywhere.

"A persistent use of films with intensifying screens and possibly the Bucky diaphragm is essential for any sort of a demonstration of direct gall-bladder evidence. Furthermore a barium meal with practically a complete gastro-intestinal examination is required to bring out adequately the secondary evidence. * * * Again, the patient must appear for examination with the gastro-intestinal tract empty."

Habitual use of the screen with an occasional film will result in failure if employed in gall-bladder diagnosis.

Diagnosis of Obscure Abdominal Lesions by the Roentgen Gastro-Intestinal Examination. W. H. Dickson, M.D., C.M., Toronto General Hospital. Am. J. Roentgenol. 10:540-546, July, 1923.

FOUR pages of descriptive detail and about two of illustrations make up this article. Dr. Pfahler in his discussion of the paper especially thanked Dr. Dickson for the discussion of the many variations of pathology, especially that of the pancreas, and remarked that brilliant diagnoses might be more frequent were more thorough study brought to bear upon the unusual instead of leaving the diagnosis with a question mark after it.

The article deals with the filling defects and deformities of the stomach, duodenum and colon caused by pancreatitis, carcinoma, cyst of the pancreas, retroperitoneal tumor and other extra-intestinal growths. Tumors of the liver, pancreas, spleen, kidneys, gall-bladder and retroperitoneal area exert a pressure, which is usually char-

acteristic, upon the adjacent hollow viscus and the lesion is thereby located. The article discusses these findings in detail.

The technique used is the same as for all other gastro-intestinal work in the author's practice, namely, barium-buttermilk meal, fluoroscopic examination with palpation. plates, in the erect, anteroposterior, prone and right oblique positions. Pneumoperitoneum has been used but the author has now discarded its use as he believes it contains an element of danger and his routine method yields better results than did the use of pneumoperitoneum.

Two aims are kept in mind: localization of the anatomical situation of the lesions and the establishment of the pathological entity of the condition.

Home Made X-Ray Diagnosis. Charles D. Enfield, M.D., Am. J. Roentgenol. 10:581-583, July, 1923.

THIS editorial is a clear cut exposition of the necessity of roentgen interpretation being done by a specialist in roentgenology and not by a layman, general practitioner, or any other specialist, unless the case is so simple that there is no danger of error.

Aside from the long training necessary to do this service well, there is another factor involved, namely, the fact that it is almost humanly impossible to exercise unbiased judgment in roentgenological diagnosis if the case has first been studied in any other way by the one who makes the roentgen interpretation. Clinical bias of course does not occur where evidence is clear cut but it is in the border-line cases where the harm is done—harm which too often reacts upon the patient's welfare and consequently upon the good name of roentgenology.

Coccidioidal Granuloma. Raymond G. Taylor, M.D., Am. J. Roentgenol. 10:551-558, July, 1923.

THE specific fungus which causes this disease usually attacks either the skin or the lungs, though its initial appearance may be in the joints. In general the lesions are classified as infectious granuloma.

The mode of onset, clinical course and pathological picture are all strikingly like tuberculosis. Eventually the infection becomes general and terminates fatally, although amputation of an affected member has been known to arrest the disease.

The natural habitat of the organism causing the lesion is not known. It seems from evidence to be native to California, most of the cases coming from the San Joaquin valley.

Nine case reports with eleven roentgen pictures are given.

Radium Emanation Ampules in the Treatment of Cancer of the Tongue. Frank Edward Simpson, M.D., Illinois M J. 44:139-142, August 1923.

IN about fifty per cent of primary tongue lesions surgical methods are of no avail and implantation of radium may give relief. In the operable cases results are as good as with surgery and some workers believe they are better.

The cervical glands may become invaded within a few weeks after the tongue lesion first appears or may not become invaded for six months. Death usually comes before distant metastases can occur.

Diagnosis may or may not be easy and usually it rests between cancer, tuberculosis and syphilis. However a primary tuberculous ulcer of the tongue is very rare. Sectioning is definite proof but is regarded as dangerous.

Implantation of radium emanation in ampules has met with such success in the author's practice that after extensive experience with other methods he has discarded them all in favor of implantation.

In ordinary cases, 5 to 20 ampules each containing one-half millicurie of emanation are inserted in the lesion and one treatment as a rule suffices to bring about healing in from 6 to 12 weeks. Details of technique were published in the *Chicago Medical Recorder* of January 1923.

End-Result Study of Dermatological Cases Treated by Roentgen Rays. C. Guy Lane, M.D., Mass. Gen. Hosp. Boston M. & S. J. 189: 174-177, August 2, 1923.

ELEVEN of twelve cases of acne vulgaris of from one to six years' duration were cured with from 4 to 15 treatments.

Ten of 14 cases of eczema showed marked improvement. These ten were of the localized type. Those of the general type did not do so well. In addition to these 14 there were five cases of sharply localized neurodermatitis which responded extremely well.

Ten of 13 cases of sycosis of one to seven years' duration showed marked improvement. Five are well and one other appeared well for one year after which recurrence took place for which treatment gave no relief.

Two cases of psoriasis did not improve. One did improve with a recurrence ten months later which, however, responded to treatment.

Five cases of chronic uticaria yielded distinctly unsatisfactory results, only one case was improved.

Sixteen (localized) of 38 cases of pruritis showed marked improvement but the general type failed to respond.

Two cases of mycosis fungoides are well one and one-half years after treatment while another case responded for only a short time.

Sixty-six cases of ringworm of the scalp were treated with complete success. The whole scalp should be radiated and standardization of apparatus is most important as too little raying will not produce epilation and too much will produce permanent epilation with scarring and telangiectasis. The action of the radiation is mechanical in that it has no effect upon the fungus itself but by removing the hair eliminates the fungi.

Two of five cases of keloid improved.

Five cases of lupus vulgaris failed to improve. The writer believes that only recent cases which show little scarring and have had little treatment previous to radiation are suitable for x-ray treatment.

Five cases of scrofuloderma were healed.

Eleven of 14 cases of epithelioma and keratosis were pronounced well after unfiltered radiation of one and one-half to two erythema doses at intervals of from three to four weeks.

Among 28 miscellaneous cases improvement occurred in several cases of warts, fungus infection of the hand, excessive sweating, certain types of lichen planus and in blastmycosis.

Report of Cases of Malignant Growths of the Bladder Treated by Resection and Radium. Henry G. Bugbee, M.D., J. Urology, 10: 159-171, August, 1923.

DIRECT application of radium by means of the cystoscope has not given satisfactory results in bladder tumors. A case treated by surgery alone is apt to terminate fatally in from one to two years. The question at present is, "How efficient is radium going to prove when used as an aid to surgery?"

The author presents 19 case reports from his own practice, 14 males, 5 females. Age varied from 40 to 90 years, only three being past 70 years of age. Six showed a papillomatous growth, 13 an infiltrating growth and all are classed as malignant although in several cases pathologists disagreed.

Most of these cases received treatment from two to three years ago, only three were reported later than December of 1921.

Ten cases are free from growth, in two the growths are rapidly receding. two were hopeless cases from the start, and the remaining five have a metastasis.

When metastasis has taken place the patient should be made as com-

fortable as is possible. Sometimes simple bladder drainage accomplishes this. A circumscribed carcinoma should be removed by resection if at all possible. Recurrences after operation are less resistant than the primary growth. All cases should be carefully watched for recurrences.

In extensive carcinoma of the bladder without metastasis, in lieu of total or subtotal cystectomy it is possible in some cases to destroy the growth by repeated insertions of radium needles —"if one bears in mind that he is trying to destroy the growth, not the patient"—using not too massive a dose but employing repeated insertions at sufficient intervals and securing free bladder drainage for sloughing and infection. Body elimination must be carefully looked after also.

Sunlight and Disease (Heliotherapy). P. M. Daneel, M.D., Staats, Germany. South African Med. Rec. 21:265-271, June 23, 1923.

DR. ROLLIER'S school in Leysin where the children's naked bodies are constantly exposed to the sun's rays has been duplicated by Dr. Francken at Lake Geneva and the results are said to be most remarkable.

These children "from far and wide with deplorable clinical histories of enlarged glands, adenoids, bronchitis, colds, etc." improve markedly under this treatment. The author states that tuberculous bones and glands seldom need surgical treatment if heliotherapy is first tried. Malta fever is said to be cured by the treatment and likewise intractable anemias, rickets, rheumatism and vague abdominal and chest conditions. Six remarkable case reports are submitted.

The history and scientific theories of the disease are discussed at some length.

Report of a Case of Erysipelas Treated with Reflected Incandescent Light. Frank Thomas Woodbury, M.D., Am. J. Electroth & Radiol. 41:247, August 1923.

A THERMOLITE bulb attached to a "goose-neck" desk-lamp fixture was used in a case of early erysipelas with very satisfactory results which were quite apparent within a few days.

A lamp was applied on each side of the patient's face each aletrnate hour for a week after which the patient was considered to be out of danger but as puffiness and smarting continued treatment was continued for another week. Alcohol compresses were used between irradiations and one-thirtieth grain of strychnine sulphate was given thrice daily.

Adhesions of Tendons Treated by Physiotherapy. Sinclair Tousey, M.D. Am. J. Electroth. & Radiol. 41:247-248, August 1923.

RESTORATION of function to a hand helpless for two years as a result of adhesions of tendons is here reported. The patient, aged 60, had had a Colle's fracture of the right wrist two years before treatment was begun. Motion, either active or passive, was quite impossible.

To remove the fibrous deposits about the tendons radium filtered through 0.4 mm. steel, 1 mm. brass and 16 mm. felt was applied for two hours every other day for three days. No skin reaction whatever resulted from this radiation.

Radium treatment was then followed by diathermy and when some movement was obtained the diathermy was supplemented by the use of the sinusoidal galvano-faradic current of about 5 ma. through both hands for fifteen minutes (daily?). Within three months from the beginning of treatment patient had a grip pressure of 22 pounds and was able to lift a shovelful of coal into the furnace.

To move the fingers and to strengthen the muscles a rythmic static induced current was applied and at the end of seven months from the first measures of treatment patient had a grip pressure of 47 pounds, complete freedom from pain and full motility and use of her hand.

Physiotherapy As An Adjunct to General Medicine. Louis Feldman, M.D., Am. J. Electroth. & Radiol. 41:249-255, August, 1923.

UNDER physiotherapy are included all therapeutic measures which are neither surgical nor medical, such as massage, manipulation, curative exercises, hydrotherapy, heliotherapy, thermotherapy, electrotherapy, mechanotherapy and x-ray, to a certain extent.

The last named is most valuable in physiotherapy in determining indications and contra-indications for treatment and in checking up the progress of treatment.

"There is no place in the field of medicine for the cultist who with narrow vision practices only one unit of therapy without regard for the merit of all others." Every graduate in medicine worthy of his calling will keep an open mind and will investigate the worth of all methods of treatment and give his patients the benefit of the best which the whole field offers his case.

The Treatment of Menorrhagia by Radium. Sir G. Blacker, M.D., F.R.C.P., London, The Lancet, 1:421, March 3, 1923.

DURING the six years ending July 1, 1923 the author has treated 77 patients by intrauterine application of radium emanation or element. Thirty-four were treated for excessive hemorrhage at the menopause; ages were 40 to 52; only one case unsuccessful Twenty-three were treated for hemorrhage associated with fibromyomata: ages 36 to 55; five cases so far unsuccessful but further treatment is being tried and success is thought likely. Eleven were unaccompanied by any disease and treatment was for excessive hemorrhage alone; ages 22 to 42; three were successfully controlled, in six complete amenorrhea resulted; two resorted to hysterectomy. The other nine cases were lost track of and so not reported.

The author considers this treatment is a valuable and efficient method for the first type of case, that it is a safe method for the second type if uncomplicated, and that it is a valuable means of treatment in the third type of case when other methods have proved useless.

Localization of Brain Tumors by Cerebral Pneumography. Walter Dandy, M.D., Am. J. Roentgenol. 10: 610-616, August, 1923.

DANDY believes that by means of the x-ray it should be possible to locate practically all brain tumors. About 15 per cent can be located from the shadows cast by calcification and from skull effects. In 35 per cent the injection of air into the ventricles aids the x-ray diagnosis.

Symptoms of brain tumor are either of localizing character or else they are those of general pressure, and it is in the latter group that the x-ray is of the greaetst aid.

He says, right in the beginning, that the process of cerebral pneumogarphy is a very dangerous one and should be employed only by those thoroughly skilled in intracranial surgery, then the danger is minimal. Compared to operation by guesswork the danger is small.

The cerebrospinal fluid is withdrawn from a lateral ventricle and air is injected, the needle being inserted through the skull opening into the posterior horn of the ventricle, the fluid aspirated and ejected. Unsterilized air is then forced in in an amount equal to the fluid ejected; by turning the head the proper way the air can be shifted to any part of the head.

Due to the difference in density in certain parts of the chamber, shadows are cast and the changes from the normal in size, shape and position (due to pressure) will render diagnosis possible. However, in one group (bilateral hydrocephalus and in which

two lateral ventricles communicate freely) all that can be ascertained is that there is a lesion between the aqueduct of Sylvius and the foramen of Magendie. Interpretation is neither simple nor "fool"-proof. The leading points in interpretation are briefly sketched.

In the discussion which followed the paper Dr. Kerr said that while in Dr. Dandy's hands the method was safe and of utmost value it might be far otherwise and even misleading in the hands of others less skilled, for instance, in cases of abnormality of the ventricles. He also mentioned that the air should be evacuated without failure as he himself might have averted a fatality had he known this and he has noticed in other cases that removal of the air brings the condition of the patient back to normal.

Dr. Baetjer said that sometimes hours of study were required to interpret the plates, and expressed his great admiration of Dr. Dandy's achievements in cerebral pneumography.

Carcinoma of the Esophagus. Porter P. Vinson, M.D., Mayo Clinic. Am. J. M. Sc. 166:402-414, September, 1923.

THE incidence of this lesion is far more common than is generally thought. The symptoms are characteristic and of about one year's duration. Men are five times more often the victims than are women and in men the lesion is more common in the middle third of the esophagus, in women in the upper third. Demonstrable metastasis is infrequent but is more common in women on account of lesions of the introitus. Trauma is not a factor and the lesion is rare under the age of forty. The x-ray is of value in diagnosis but it is not infallible. Radium and x-ray have not as yet cured any case but do offer palliation in many cases. Surgery is of very little curative or palliative value but mortality in untreated cases is 100 per cent.

Cellular Regeneration under Ultra-Violet Stimulus. A. J. Pacini, M. D. Am. J. Electroth. & Radiol. 41:226-227, July, 1923.

IN treating ulcerated surfaces it must be remembered that actinic tolerance is dependent upon a normally functioning germinal epidermal layer and if this is absent, or not functioning, no tolerance can be established. Also the cellular regerative stimulus produces embryonic epithelial cells without the same degree of resistance that older cells have. Therefore the exposure time used in ultraviolet treatment of ulcers should not be increased until these cells have existed long enough to acquire the hardening of old established epithelium. Any increase at all is apt to be too drastic for these young cells. Also, for healing, it is necessary that the calcium content of the blood have its normal value. If response to ultraviolet treatment for ulcer is sluggish then systemic raying, which increases the calcium content of the blood, should be resorted to.

Liquid Paraffin for Cooling the Anticathode of X-Ray Tubes. T. Klason, M. D., Acta Radiologica, 2:197, No. 6, May, 1923.

THE writer reports very satisfactory results from the use of paraffin (which has a higher boiling point than water) to cool the anticathode of x-ray tubes.

When using water the tube begins to rock about from the motion of the boiling water within about seven seconds. When paraffin is substituted for the water there is no perceptible motion even after two minutes.

A Radium Compensator for Ionization Measurements. Rolf M. Sievert, Stockholm. Acta Radiologica 2: 156-165, No. 6, May, 1923.

The author's summary thus describes this instrument for rapid observation of the intensity of β and γ-rays. "The ionization current in a small chamber is compensated by means of another similar chamber, the latter together with a sensitive electrometer being placed in a lead box. The ionization in the compensation chamber is produced by the β-rays from a radium preparation, containing about 0.2 mgr. radium element. The compensation is brought about by increasing or decreasing the distance between the preparation and the last mentioned chamber accordingly, until the electrometer thread remains in its zero position, irrespective of a switch for earthing being disconnected or not. The distance is read off on a micrometer. Investigations of the possible error sources show that the measurement of one intensity can be made in 20 seconds without a greater error than one-half to two percent, depending upon the magnitude of the intensity."

Physical Facts of Roentgenological Importance. Arvid Odencrants, Ph. D., Acta Radiologica, 2:128-138, No. 6, May, 1923.

THIS paper comes from the Physical Institution of Stockholms Hoegskola Laboratory for Scientific Photography. It gives a brief summary of the physical laws underlying the science of radiology. It discusses the origin of the rays, continuous and characteristic spectra, diffuse and fluorescent absorption and the photographic and luminescent effects. The importance of the laws for practical work is stressed, especially is importance of exact terminology stressed.